THURSDAY, JULY 22, 1915.

FORESTRY AND TREES.

(1) *Studies of Trees.* By J. J. Levison. Pp. x +253. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1914.) Price 7*s.* net.

(2) *Forest Valuation.* By Prof. H. H. Chapman. Pp. xvi+310. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1915.) Price 8*s.* 6*d.* net.

(3) *Chinese Forest Trees and Timber Supply.* By N. Shaw. Pp. 351. (London: T. Fisher Unwin, 1914.) Price 10*s.* 6*d.* net.

(1) THIS is an interesting book on the study of trees, specially suitable for use in the schools of Canada and the United States. Three chapters deal with the identification of the common North American trees, and of a few introduced European species, as the Austrian and Scots pines, Norway spruce, Alpine larch, horse-chestnut, Lombardy poplar, etc. Other chapters are devoted to the structure and habit of these trees, and their protection against animal and fungoid attacks. One chapter is taken up with elementary forestry, and another with the recognition and properties of the timbers in common use. The concluding chapter is an outdoor lesson on trees. The book is copiously illustrated; but, as is usual in publications of this class, the illustrations are of unequal value. The price, 7*s.*, will make it unavailable for use in schools in this country; but it deserves a place in town libraries. It is said to be obtainable in separate pamphlets, each dealing with one of the subjects treated.

The author describes in a concluding paragraph the Tree Clubs which have been founded in Brooklyn, Newark, and other eastern cities, with the object of interesting children in the care of trees. "The members of these clubs are each given the tree warden's badge of authority, and assigned to some special duty in the preservation of local trees. A plan of study and of outdoor trips is laid out for them by their director, and at stated periods they are given illustrated lectures on trees and taken to the neighbouring parks or woodlands." In happier times, we may also have tree wardens and tree clubs, which will render impossible such destruction as occurred two or three years ago in the felling of the beautiful relic of an ancient wood, the King's Hedges, near Cambridge, as soon as it had become the property of the county council.

(2) Forest valuation is concerned with the determination of the value of standing timber, of the land on which it grows, and of the forest as a whole, as well as with the rental produced. It compares also the financial results obtained in forestry with those yielded by other enterprises, and solves the merits of different methods of treatment of the forest. The importance of forest valuation cannot be gainsaid, as woods and plantations must be valued in all cases of sales, and whenever the property is assessed for taxation. Moreover, when schemes of afforestation are being considered by the State, by corporations, by companies, or by private owners, the only possible inducement for such undertakings must be based on the financial results that are reasonably to be expected. The correct appreciation of such results is by no means an easy matter. Forestry valuation deals with periods of time which are much longer than those that are ever considered in other financial considerations. Life insurance has an average risk of fourteen years, and earns about 4 per cent., obviously attracting much capital. Forests, in some cases, as coppice, bring in returns in ten to twenty years; but as a rule 40 to 120 years is the age of an ordinary plantation when felled. It is not yet agreed what rate of interest should be earned on the capital invested in forestry; and, in addition, correct and full data on which to base the calculations of the financial returns are not available in this country.

An extensive literature on the subject has been developed during the past seventy years by numerous German and French writers; but in England we have only had two serious writers—the late Dr. Nisbet and Sir W. Schlich. The latter, in his "Manual of Forestry," vol. iii., pp. 111 to 164, presents the gist of the matter in a condensed form, somewhat difficult to students who have not been previously trained, both in economics and in actuarial methods.

Prof. Chapman's book is fairly complete and has great merits. The subject proper is prefaced by four excellent chapters entitled "Values," "Outlay and Income," "Interest," and "Valuation of Assets," which will enable the student to understand the principles underlying the business of forest production. The succeeding chapters are highly technical, yet at the same time very practical, as befits a professor in an American university. He introduces, for example, a number of forms for use in forest book-keeping.

In the chapter on profits, Prof. Chapman discusses the question of private *versus* State ownership of forests; and considers it impossible for private forestry to be practised now on a large scale. He adduces conclusive reasons why the Government of the United States must con-

tinue to increase the extent of the national forests, and to take on itself more and more the production of timber. The book is replete with useful formulæ and tables, and can be recommended as the best text-book on forest valuation yet published in the English language.

(3) This book on the forest trees and timber supply of China undoubtedly contains some interesting pages. The author, a Chinese customs official lately stationed in Manchuria, gives a brief history of the forests and timber trade of this region, with a description of the modes of felling timber and rafting it on the Yalu and Sungari rivers. His slight sketches of the forest conditions of the other provinces occasionally give some information of value. It is sad to learn that the ancient hunting forest of the emperors, the Weichang in Chili, which Colonel Wingate estimated to be 400 square miles in extent in 1910, is now reduced to 100 square miles, owing to the ravages of the peasants since the revolution. Foochow and Hunan appear to be the most prolific of the provinces in timber supply; but great forests also exist in Szechwan, Kweichow, and Yunnan, which are as yet inaccessible. Until, however, a report is made by some competent forester, it is impossible to gauge the wealth of timber in the interior of China, as many of the forests reported by missionaries and travellers, while botanically marvellous owing to the variety of the shrubs, trees, and herbs, contain only a sparse supply of useful timber trees.

The volume is an uncritical compilation from various books, journals, and official reports, which are indicated in a bibliographical list. It is unfortunate that most important sources of correct information have not been consulted, such as Bretschneider's learned volumes, "European Botanical Discoveries in China" and "Botanicon Sinicum." The "Index Floræ Sinensis," an enumeration of all known Chinese plants, showing their exact distribution, which was issued by the Linnean Society, has not been used by Mr. Shaw, who scarcely appreciates the necessity for correct nomenclature. The *Kew Bulletin*, which in many volumes contains excellent notes and articles on Chinese trees and their peculiar products, is not quoted. Valuable papers on the Chinese names of trees and shrubs, which appeared some years ago in the journals of the Shanghai and Tokyo branches of the Royal Asiatic Society, have escaped notice.

The book has consequently no scientific value; and its numerous errors and omissions cannot be dealt with in a brief review. One may, however, give an instance. Mr. Norman Shaw prefaces a confused account in six pages of an important coniferous genus, with the statement that "the different species of pine in the Chinese region appear never to have been classified." Is he unaware that his namesake, Mr. G. R. Shaw, has fully described the Chinese pines in his great monograph, "Genus Pinus," and in vols. i. and iv. of "Plantæ Wilsonianæ"? The fascinating notes appended to the latter by Mr. E. H. Wilson would have provided our author with trustworthy readable matter, and saved him from such erroneous statements as that *Pinus maritima*, a Mediterranean species, is a native of China; and that *Pinus koraiensis*, a northern type not growing wild south of Korea, is met with in southern China.

The Chinese names of trees are not invariably given, and are often incorrect. Confusion of names apparently accounts for such errors as that the leaves of the Ailanthus (*Chou-chun*, p. 204) are used as a vegetable, the species thus employed being *Cedrela sinensis* (*Hsiang-chun*); and that the wood used for musical instruments is Sterculia (*Wu-tung*, p. 256), whereas it is *Paulownia tomentosa* (*Pao-tung*), a beautiful and common tree in China, not mentioned in this book. It is the pine-apple and not the screwpine (p. 307) which yields the fibre used in making fine cloth in Yunnan. Botanical errors are numerous, as the inclusion amongst Manchurian conifers of three species, *Larix leptolepis*, *Picea hondoensis*, and *Picea polita*, which are confined to Japan.

The section of the work, pp. 203–309, devoted to trees is inadequate and confused; and we advise readers interested to consult the books indicated by us above, and, in addition, Mr. E. H. Wilson's "Naturalist in Western China," which is replete with valuable and correct information about Chinese trees and their products.

Mr. Shaw's forestry is as unsatisfactory as his botany. We eagerly opened the book to learn something about the extensive afforestation carried on since 1899 in the German colony of Kiaochao. This is dismissed in a short paragraph giving scarcely any information about the species employed and their success or failure. Tree planting at Weihaiwei and Hongkong, effected by the British Government, receives equally inadequate treatment. As the author mentions amongst his correspondents Prof. Baillie, of the Nanking University, one expected a full account of the interesting forestry work begun by the latter in Kiangsu. Mr. Shaw merely says (p. 81) that "credit is due to Prof. Baillie for his afforestation scheme on the hills near the old capital."

The Nanking professor's pioneer afforestation work, based on co-operation with the Chinese gentry, deserved description. Some details were published in the *National Review* (China) of April 25, 1914, the list of species employed being given, etc. The great difficulty of afforestation in China seems to be danger from fire, 200,000 trees, for example, having been burnt in the experimental plantation on Purple Mountain in 1913. Professor Baillie since then has established fire-lines, 30 to 100 ft. wide, which are let to Chinese farmers, who keep these lines cultivated and at the same time take care of the adjoining plantations.

The book is illustrated by thirty-three reproductions of photographs, some of which have appeared in well-known books of travel. Those taken from Major Osaki's "O Ryoko" represent well the methods of logging and rafting timber in Manchuria. Twelve photographs by Mr. Purdom, a recent plant collector in North China, are of unequal merit, that of the Chinese horse-chestnut being the best. There is also a good picture of *Pinus bungeana* at Peking, a tree often planted in temple grounds, the bark of which is of a milky-white colour, and peels off in patches like a plane, thus giving the stem an extraordinary appearance.

DYNAMOMETERS.

Dynamometers. By Rev. F. J. Jervis-Smith. Edited and Amplified by Prof. C. V. Boys. Pp. xvi+267. (London: Constable and Co., Ltd., 1915). Price 14*s.* net.

THE late Mr. Jervis-Smith, a vicar at Taunton until in 1886 he took charge of the Millard engineering laboratory at Oxford, was a very modest and ingenious enthusiast in the experimental study of natural science. He was particularly absorbed in the study of methods of measuring mechanical power. A dynamometer measures the product of force into velocity. The chemical balance illustrates the great accuracy with which we can measure force and there is also great accuracy possible in measuring speed, but the measurement of their product with accuracy is a very different thing. To measure the electrical power given out by or given to a machine is very easy; however large or small the power may be, our measurements may be made accurate to the fourth or even to the fifth significant figure. It is only in very exceptional cases that the measurement of mechanical power is correct to two significant figures.

Mr. Jervis-Smith left his MSS. in an incomplete form. The book is not a mere collection of lecture notes; many parts of it are quite finished, but on the whole it is rather disconnected. The author's sympathetic and admiring friend, Prof. C. V. Boys, has edited the book, and he has done this evidently as a labour of love. He has not attempted to make the book a complete treatise, but he has introduced between brackets interesting statements and amplifications which tend to make it a connected whole.

The author does not confine himself to dynamometers. He gives accounts of integrators, planimeters, and other contrivances which are related in one way or another to his main subject. We get the idea that this is a scrapbook in which he placed anything that interested him. There are places—as at the beginning, but elsewhere also—where he is evidently writing a book, but in other places we have evidence of scissors and paste. It seems to have been his intention not just to print these scraps, but to use them as a foundation for better descriptions of his own. We are glad to have them, as they would otherwise have to be searched for in many publications, and although some of them might have been omitted with advantage, we regret that they are not more numerous.

There are parts, as when he deals with friction and planimeters, where he gives a valuable, exhaustive list of references. If he had lived he would no doubt have done the same for other parts of the subject. Sometimes, as in the rope dynamometer brake (p. 71), the descriptions are not easily understood as no figure is shown, and indeed all the rope dynamometer part is rather weak. The descriptions of the water brake of Froude and other things are too long and yet simple explanations are wanting. A certain air brake is described in too much detail, and the account of the behaviour of a copper disc moving in a magnetic field is tedious. The account of Borda "On the Flow of Fluid from Orifices in Vessels" is quite out of place in this book. A short account of General Morin's work on friction would be better than a translation of the original paper. We feel sure that if the author had lived he would have made the whole book as perfect as part of it is, but we can understand why the editor may have been unwilling to discard or alter too readily some of the things we have mentioned. After all they are interesting. The book gives the most interesting and complete account of dynamometry that is known to us, and it owes a great deal of its interest to the additions made by the editor. In a few places we think that Prof. Boys is not quite fair. Mr. S. G. Brown did not merely

employ a known principle as to friction in his famous submarine telegraph relay; he was the discoverer of the principle. The same may be said about the description of Brown's mechanical relay. We think that Prof. Boys is occasionally misled by assuming that his own very intimate knowledge of phenomena is shared by other people. J. P.

MATHEMATICAL TEXT-BOOKS.

(1) *Subjects for Mathematical Essays.* By Dr. C. Davison. Pp. x+160. (London: Macmillan and Co., Ltd., 1915.) Price 3*s.* 6*d.*

(2) *Junior Algebra.* By A. G. Cracknell and A. Barraclough. Pp. vi+280. (London: University Tutorial Press, Ltd., 1915.) Price 2*s.* 6*d.*

(3) *Papers Set in the Qualifying Examination for the Mechanical Sciences Tripos,* 1906–1913. Pp. 90. (Cambridge: At the University Press, 1914.) Price 2*s.* net.

(4) *A Shilling Arithmetic.* By W. M. Baker and A. A. Bourne. Pp. xiv+192. (London: G. Bell and Sons, Ltd., 1915.)

(5) *Practical Mathematics Second Year.* By A. E. Young. Pp. xi+164. (London: G. Routledge and Sons, Ltd., 1915.) Price 2*s.* net.

(6) *The Laws of Algebra.* An Elementary Course in Algebraic Theory. By A. G. Cracknell. Pp. vi+68. (London: University Tutorial Press, Ltd., 1915.) Price 1*s.*

(1) THIS collection of essays will be found of the greatest value in the training of mathematical scholarship candidates. Such work as this enables a student to coordinate his knowledge, and so consolidates the material that is floating vaguely about his mind, when he has completed the various courses of reading prescribed for him. It is indeed mainly by essay work that he begins to see the bearing of one subject on another and to appreciate the help which can be derived from the interfusion of subjects. We do not therefore recommend the use of this book merely because it will stand the candidate in good stead for examination purposes, but because we believe that the greater breadth of outlook essay work produces is of real educational value to him, and because it plays a part in his mental development which no other form of exercise can achieve.

(2) This course takes the reader as far as quadratic equations, and the two final chapters deal with indices and logarithms. In addition to illustrative examples, there is a considerable amount of explanatory matter. The former is essential, but it is open to question whether junior students can profitably read the discussions which text-books often contain: for example, on page 70 we find "Related Unknowns.—One of the chief uses of algebra is that of solving problems where it would be either difficult or impossible to solve them by arithmetic. The method is to represent the unknown quantities by letters, then to express the problem as an equation and to solve this equation." In our view, such passages as these merely overload the book and assist neither the pupil nor the teacher. There are no particularly original features, but the examples are well arranged and provide a sensible elementary course.

(3) The reprint in a cheap and compact form of papers set in the Mathematical and Engineering Triposes at Cambridge is of real service to a large circle of students. The general character of the papers is evidence of the recent changes in mathematical teaching. Those engaged in the higher work in secondary schools will find here much that will enrich their weekly problem papers. The questions are both practical and stimulating.

(4) This small volume includes all the arithmetic that in our view ordinary students require and some things, such as true discount or inverse compound interest, they should omit. If the general education is to include, as we believe it ought, trigonometry, practical mechanics and, if possible, the ideas of the calculus, it is essential that arithmetic should be merely a means to an end, a preparation for other work rather than a subject in itself. It is the comparatively slight dimensions of this text-book that constitute its chief claim to favourable consideration.

(5) The author has already published a course of practical mathematics for first year technical students: this volume contains the subject matter of the second year course. In this volume, as in the first, there is a first-rate set of examples, and we have no hesitation in recommending it for extensive use.

(6) This discussion of the meaning and validity of the fundamental laws of algebra is intended for senior divisions of secondary schools. It includes rational and irrational numbers, and rational indices, but excludes imaginaries, infinities, limits, and irrational indices. The language is throughout simple and the argument is set out clearly, but we are doubtful whether the author's partition is satisfactory. The theory of limits has now assumed so prominent a place in modern analysis that it is hard to refuse to admit it into the school curriculum, and it seems wise therefore to take it in conjunction with any substantial discussion of irrational numbers.

ELECTRICITY AND MAGNETISM.

(1) *Elementary Electricity and Magnetism.* By W. S. Franklin and B. Macnutt. Pp. viii + 174. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1914.) Price 1.25 dollars net.

(2) *Advanced Theory of Electricity and Magnetism.* By W. S. Franklin and B. Macnutt. Pp. vii + 300. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1915.) Price 2.00 dollars net.

THESE books are written purely with a view to the practical application of electricity and magnetism. The choice of matter is excellent from this point of view, and it is all presented in a lucid, readable, and original manner, being illustrated with a large number of excellent diagrams. Experimental phenomena are usually described first, and to give students a grasp of their meaning mechanical analogies are given. Most of these analogies are excellent, but one gets the impression that on the whole too much attention is devoted to them, and that some of them could profitably be omitted. The introduction of the terms abampere, abvolt, and abohm for the absolute units of current, E.M.F., and resistance is a feature of the books. The electromagnetic system only is used, and in the advanced book the authors boldly declare that they are ignoring the electrostatic system altogether, a procedure that is perhaps wise, considering that the practical aspect of the subject predominates.

(1) The elementary book commences with a description of the most important phenomena in electricity from a practical point of view. Only the most elementary things in magnetism are described, and this part of the subject is of importance only in its relation to electricity. The action of electromagnets on wires carrying currents is described very early in the book, and the reverse phenomenon—the action of currents on magnets, which one is accustomed to find as a fundamental principle, does not appear till later. Great prominence is given to the "side push" on wires in a magnetic field (the term is the authors'), and, once described, its applications to the D'Arsonval galvanometer and to the dynamo follow. The tangent galvanometer is not described, as it is not a practical instrument. The "side push" is again employed in connection with magnetic intensity, which is defined as "the side force per abampere per unit length of wire." The chief practical things to which attention is given are the dynamo, motor, transformer, and induction coil.

(2) The advanced book is more of the usual type. The usual accounts of magnetic phenomena are given and the definitions here are normal. When electromagnetism is introduced a novel definition of unit of current—the abampere—is given. This is defined as "the force per unit length of wire per unit field intensity." The meaning of the authors is clear, but their wording is unfortunate, as they define current as the "force." Whereas in the elementary book attention is devoted chiefly to the dyamo, etc., the advanced book seems to be written principally for telegraph engineers, as a very large amount of space is devoted to waves on wires. As an application of permanent magnetism, a chapter is devoted to ships' magnetism and the compensation of the compass. The chapters on electrostatics suffer from vagueness on account of the ignoring of the electrostatic system of units. For instance, the capacity of a parallel plate condenser is given as

$$C \text{ (in farads)} = 1/B \,.\, a/x,$$

where "a" is the area of one plate in sq. cm., x the distance apart of the plates, and B is a constant $= 1{\cdot}131 \times 10^{13}$. However, again the practical aspect is kept in view, and space is devoted to such things as the design of insulators for cables and the capacity of a transmission line.

Both books will be found of great value to students to whom the practical side of electricity and magnetism is the all-important thing, and in fact they will also be profitable to others if read in conjunction with some of the more abstract treatises.

A large number of examples is given with each chapter. J. R.

OUR BOOKSHELF.

Mechanism of Steam Engines. By Prof. W. H. James and M. W. Dole. Pp. viii + 170. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1914.) Price 8*s.* 6*d.* net.

THE purpose of the authors in producing this book has been to provide an elementary treatise on the kinematics of reciprocating steam engines and steam turbines, and to make clear to the beginner the mechanical principles on which a steam engine operates. Special attention is given to valve gears and governing devices; the underlying heat theory is not treated. The book opens with a general discussion of a reciprocating steam engine, followed by types of single-valve engines. The valve ellipse, together with the Zeuner, Reuleaux, and Bilgram valve diagrams are described, and some typical single-valve problems are worked out. Centrifugal-throttling, crank-shaft and other governing devices are included, also riding cut-off valves and their governing devices. The book closes with sections dealing with reversing gears,

valve setting, and turbine valve mechanisms and governors.

The volume is noteworthy for the clearness of the drawings (mostly taken from working drawings), and for the lucidity of the text. It is difficult, however, to state what precisely would be its position in the engineering courses at colleges in this country. This is owing to the matter being almost wholly descriptive. Students of engineering learn best by doing, not by merely listening or reading. Numerous valve diagrams are given, but no student desires to copy these, and no definite exercises are given to be worked out by the student himself. As a minor matter, we may point out that it would have been an advantage if even one leading dimension had been inserted in the detail drawings. It is difficult for beginners to sort out which devices are suitable for large and which for small engines. The book, however, can be recommended to any student who wishes to improve his knowledge of the construction of valve and governor details.

Reports from the Laboratory of the Royal College of Physicians, Edinburgh. Edited by Dr. J. J. Graham Brown and Dr. J. Ritchie. Vol. xviii. (Edinburgh: Oliver and Boyd, 1915.)

THE directors of every research institution have to face a peculiar difficulty connected with publication. In issuing an account of the various inquiries conducted in the laboratories under their charge two modes of publishing are open to them. They may issue a special report, or they may allow the workers in the laboratories to contribute their results to appropriate professional journals or proceedings of societies. A special report is expensive; it does not secure the ear of the scientific public so well as professional journals do. The laboratory of the Royal College of Physicians in Edinburgh has combined these two methods; it has collected the papers contributed to various journals by its workers during 1913–14, and issued them as the thirteenth volume of its Reports. In all there are thirty-two papers, every one of them representing a definite contribution to the basal subjects of medicine. Four papers give an account of the researches of Dr. J. P. McGowan into the nature of sarcocyst, associated with the disease of sheep known in Scotland as "Scrapie."

Four papers are devoted to human anatomy, Dr. J. S. Fraser's sections of the inner ear being of particular merit. The remaining papers are devoted to biological chemistry, pathology, and bacteriology. We note particularly the research carried out by the late Dr. Alexander Bruce—whose death was a serious loss to British neurology—and Dr. James W. Dawson on a curious form of tumour which occurs in the central nervous system. A study of the minute structure of these neuromata supports the multicellular theory of nerve-fibres. Dr. D. P. B. Wilkie's important observations on the clinical signs of acute obstruction of the appendix vermiformis as distinguished from acute inflammation of the appendix also appears in this volume of reports. The thirteenth volume is one on which its editors, Dr. J. J. Graham Brown and Dr. James Ritchie, superintendent of the laboratory, may be warmly congratulated.

The Poison War. By A. A. Roberts. Pp. 144. (London: W. Heinemann, 1915.) Price 5*s.* net.

MR. A. A. ROBERTS, who is described as a member of the Chemical Society of France and also of the Society of Chemical Industry, has given the public a book to which no one with any chemical knowledge will deny the epithet "remarkable." Two or three short extracts from its pages will perhaps best illustrate its value.

On page 57 we find "The white smoke referred to, upon the explosion of German shells, is caused by the union of phosphoric and phosphorus acids with the oxygen of the air." On page 90 we are told: "Toluene is a colourless liquid obtained from resins such as tolu: the latter being the product of a South American tree. Some of the medicinal preparations of this resin are well known to the public, as 'Balsam of Tolu' and 'Friars Balsam.'" In reference to gun-cotton, on page 91 we learn: "Reverting to the subject of gun-cotton, this explosive is now made by soaking cotton or waste in nitric acid. Cotton is indispensable, as it absorbs the oxygen and nitrogen contained in the acid, and is a combustible substance." On page 98 we read: "Nitro-glycerine, or even gun-cotton, if burnt in an open vessel, will not explode, but the moment they are fired by detonation explosion follows, the explosion being due to decomposition." The non-poisonous character of nitro-glycerine is illustrated by the following statement on page 99: "A laboratory employé, in another instance, partook of two ounces of nitro-glycerine, mistaking it for chocolate, and on the morrow was none the worse for his stupidity."

Indian Mathematics. By G. R. Kaye. Pp. 73. (Calcutta and Simla: Thacker, Spink and Co., 1915.)

MR. G. R. KAYE's booklet gives a summary of the actual contents of Indian mathematical works, translations of original passages, an approximate chronology, and a bibliography. The net result of recent work in this field is to reduce still more the claims once made on behalf of Indian mathematicians, both in respect of priority and in that of originality; two main questions are still unanswered—who invented the decimal notation now current, and what is the complete history of the Pellian equation? Mr. Kaye suggests that India is probably indebted to China for some of its analysis, just as it is certainly to Greece for its geometry (in Arabic translations or otherwise); it is to be hoped that Chinese documents will be forthcoming to throw light on these and other matters. Meanwhile, such a work as this of Mr. Kaye's is very useful as a trustworthy conspectus of what is actually known about early Indian mathematics at present.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

The Structure of Magnetite and the Spinels.

THE structure of the spinel group of crystals is very interesting. These crystals are cubic, and possess the greatest possible number of symmetries. The composition is given by the formula, $R''R'''_2O_4$, where the divalent metal R'' may be Mg, Fe, Zn, or Mn, and the trivalent metal R''' may be Fe, Mn, Cr, or Al. Magnetite is $FeFe_2O_4$.

The structure is fundamentally the same as that of the diamond. Each carbon atom of the diamond is to be replaced by the divalent metal atom; the distance between two neighbours being 3·60 Å.U. in magnetite as against 1·53 Å.U. in diamond. The four oxygen atoms are arranged in a regular tetrahedron about the divalent atom. The lines joining the latter to the former are parallel to the four cube diagonals. Any two neighbouring tetrahedra point towards each other. If each perpendicular from a tetrahedron corner on the opposite face is produced it encounters another tetrahedron, passing first through the middle point of a face and then through the opposite corner. A trivalent atom lies on each such connecting line, half-way between the tetrahedra. The distance between a divalent and the nearest trivalent atom is 7·20 Å.U. Four trivalent atoms are associated with each tetrahedron, but each atom is shared by two tetrahedra. As in other cases already examined, the molecule has no separate existence. The size of the tetrahedron may not be the same in all members of the group of crystals. The divalent atom lies at the centre of a tetrahedron of oxygen atoms, and the trivalent at the centre of an octahedron.

W. H. BRAGG.

Leeds, July 12.

The Magnetic Storm of June 17, and Aurora.

PROF. BARNARD'S interesting letter dated June 25, in NATURE of July 15, on what is termed "The Great Aurora of June 16, 1915," is at first sight rather puzzling to the non-astronomical reader. The large magnetic storm began about 1.50 a.m. on June 17. On June 16, it is true, there was a magnetic disturbance, but not such as to suggest a striking auroral display. The explanation presumably is that Prof. Barnard is referring to an astronomical day, commencing at Greenwich noon on June 16. This, at least, would explain his statement that at Wisconsin (about 90° W.) at 21h. 25m. "the sky was bright with dawn." This one would expect between 3 and 4 a.m. local time. If this is correct, then the first auroral appearance chronicled by Prof. Barnard was at 3.30 a.m. on June 17, Greenwich civil time, and the maximum brilliancy about 8.15 a.m. It was principally during these morning hours that the Kew magnetic curves had the rapid oscillatory character usually associated with aurora and earth currents. The newspaper reports quoted by Prof. Barnard seem to fit this explanation.

Passing to the Rev. A. L. Cortie's letter (p. 537), it really emphasises the difficulty of deciding whether individual sun-spots and magnetic storms are connected. There are often a number of spots visible at one time. A spot remains visible for a number of days, during which there may be several magnetic storms. If spots cause storms, the rule one spot one storm may not be observed. If I selected any given date, storm or no storm, the chances are Father Cortie could supply a spot. I think Father Cortie has not quite grasped my argument that quiet days show the twenty-seven-day period equally with disturbed days, and that one can scarcely associate them with limited areas or "anti-spots." If one associates them, as he now seems to do, with an undisturbed state of a whole solar hemisphere, why not equally associate storms with a generally disturbed state of a whole hemisphere? As a matter of fact, the average quiet day seems associated with a practically average state of solar spottedness. The 600 quiet days selected by the Astronomer Royal from 1890 to 1900 gave for Wolfer's provisional sun-spot frequency a mean value of 41·28, the mean from all days of the eleven years being 41·22. They showed the twenty-seven-day period very clearly. C. CHREE.

Richmond, Surrey, July 17.

Surface Tension and Ferment Action.

IN NATURE of June 17 Messrs. E. F. and H. E. Armstrong criticise the conclusions drawn by Mr. Beard and myself in a paper published in the Proc. Roy. Soc. of June 1, under the title "Surface Tension and Ferment Action." We drew the conclusion that the action of invertase was inhibited by surface tension. According to Messrs. Armstrong the inhibition observed under the conditions of our experiments was due simply to a minute trace of alkali given off by the glass. They state in confirmation of their view that the action of the alkali given off by ordinary glass is so marked that it is impossible to obtain consistent results with invertase, unless hard glass vessels, test-tubes, and storage bottles are used. That is certainly not our experience. We failed to find any difference in the readings between two mixtures of cane-sugar and invertase, of which one was kept in contact with glass beads at medium temperatures, as long as the amount of invertase used was relatively large. Our experience in that respect is apparently in accordance with that of Sörensen, who states that the effect of the alkalinity of glass makes itself felt only in the case of invertase solutions which have been especially purified.

In our experiments an inhibition was noticed only when the amount of invertase was relatively small. Under these conditions an alteration in the hydrogen-ion concentration produced by the minute trace of alkali given off by glass may have had some share in producing an inhibition, but it does not account for certain features of the phenomenon, which we have been careful to emphasise in our paper. If the alkali from the glass was entirely responsible for the effect one would expect the inhibition to persist in its entirety after the glass beads have been removed. This was found not to be the case. Again, the weakening of an invertase solution, which had been allowed to stand in contact with glass beads at medium temperatures and which we ascribed to absorption of the ferment by glass, cannot be explained on the ground put forward by Messrs. Armstrong. Their view necessitates the assumption of so large an amount of alkali given off by glass to an invertase solution, that it should be detectable by such an indicator as phenolphthalein. This again was not the case.

The interruption of my work has unfortunately delayed the completion and publication of similar observations with diastase carried out by Mr. McCall and myself. It was found that the inhibition produced by extending the surface-glass water could be almost completely removed by coating the glass with a thin film of a surface-active substance, such as methyl alcohol, ethyl alcohol, amyl alcohol, ether. On the other hand, films of ligroin and xylol deposited on the glass failed to remove the inhibition.

Such facts, while not explicable on the ground that the inhibition is due merely to a trace of alkali derived from the glass, form a confirmation of the theoretical considerations put forward in our paper.

July 7. W. CRAMER.

Origin of a Mathematical Symbol for Variation.

As a contribution to the history of algebraic notation it may be worth while to point out that the symbol $\propto$ for variation was introduced by William Emerson. In his "Doctrine of Fluxions," third edition, London, 1768 (first edition, 1749), he says on p. 4:—"To the common Algebraic Characters already receiv'd I add this $\propto$, which signifies a general Proportion; thus, $A \propto \frac{BC}{D}$, signifies that A is in a constant Ratio to $\frac{BC}{D}$; that is (if a, b, c, d be other Values of these Quantities) $A : \frac{BC}{D} :: a : \frac{bc}{d}$; and thus every general Proportion is to be understood." FLORIAN CAJORI.

1 Gordon Street, Gordon Square, London, W.C.

SCIENCE AND MUNITIONS OF WAR.

WE give in another column the names of the members of the Inventions Board which is assisting the Admiralty in the co-ordination and encouragement of scientific effort in relation to the requirements of the Naval Service. The Central Committee and the Panel of Consultants form as strong a body of expert opinion as it would be possible to bring together; and their judgment upon scientific matters submitted to them may be accepted with confidence. Suggestions and inventions sent to the Admiralty will, if they relate to naval matters, first be considered by officials of the existing staff, and any promising ideas or devices will be passed on to the Central Committee, consisting of Lord Fisher, Sir J. J. Thomson, Sir C. A. Parsons, and Dr. G. T. Beilby. This committee, when necessary or desirable, will refer particular points to members of the panel of consultants, which includes leading workers in chemistry, physics, metallurgy, and various branches of engineering science. The president of the Royal Society is one of the consultants, and with one exception all the other advisers are fellows of the society, which is thus giving of its best to the service of the country.

Since the early days of the war the Royal Society has been in close touch with the naval and military authorities with regard to scientific problems presenting themselves in the course of the operations. In the autumn the Council set up an organisation which has been expanded in various directions to meet the continually increasing requirements of the Government for scientific assistance. It consisted essentially of a general controlling committee, which was at first appointed *ad hoc*, but is now the Council itself; and sectional committees, each of which represents one of the several branches of science concerned, namely chemistry, engineering, physics, and physiology. Each committee has been placed by the council in charge of a chairman of acknowledged eminence. The Governmental departments concerned have nominated special representatives who sit as members of the sectional committees, and through them and the committees' own officers confidential relations have been established with those departments. The committees also are in touch with the scientific institutions and manufacturing centres throughout the country. These committees as working bodies are necessarily limited in size, having regard to the very confidential nature of the subjects submitted to them; but they avail themselves largely, as circumstances require, of the services of investigators outside their own membership.

The value of the work thus accomplished was publicly recognised by the Prime Minister lately in his remarks in the House of Commons. But though the Government has acknowledged that scientific men have rendered valuable assistance in connection with problems arising out of the war, no definite scheme seems yet to exist for the organisation of our scientific forces into a composite body. The Chemical Society, as we announced on July 8, has taken steps of its own accord to form a consultative council upon which kindred societies such as the Institute of Chemistry, the Society of Chemical Industry, the Society of Public Analysts, the Pharmaceutical Society, and the Institution of Mining and Metallurgy will be represented. Scientific and industrial knowledge and interests are thus intimately associated, as they should be, but the relation of this group of chemical societies to the Physical Society, which has also formed a committee to consider suggestions and inventions, or to the war committees of the Royal Society, does not appear to have been settled. Unless there is close co-operation between the committees of the various scientific societies it is difficult to see how overlapping will be prevented or how combined expert knowledge can be concentrated upon physical, chemical, and engineering problems requiring early and practical solution.

In addition to appointing committees to consider suggestions or inventions, the Royal, Chemical, and Physical Societies have taken steps to obtain registers of their fellows classified according to special knowledge and to scientific services which the fellows are willing, as well as specially qualified, to perform. The idea in each case is to secure co-operation among the fellows of the particular societies, and to examine by means of committees any promising suggestions relating to munitions of war or kindred subjects. No one knows precisely what will be done with the registers when they have been completed. Each society seems to be compiling its list independently and without any clear view of the use which will be made of the experts' services which will become available by the response to its circular. No scheme has yet been put forward by which definite national duties will be assigned to the hundreds of scientific men who are enrolling themselves on the registers of their respective societies.

The case is different with men who are

capable of taking their places in workshops. A register of the names and addresses of all persons who are willing to devote either the whole or some definite part of their time to industrial service of the kind indicated is being made at many engineering laboratories, so that no one with any mechanical aptitude need now lament absence of opportunity of employment in national work.

In a number of engineering laboratories of universities and technical colleges in different parts of the country, short courses are now being conducted by means of which, for a nominal fee, preliminary training can be obtained which will enable suitable persons to be recommended by the Local Munitions Committees for employment in the manufacture of munitions of war. Practical experience of employers has shown that comparatively unskilled assistance may materially increase the output of munitions in a district. Of course, persons who have already had some experience in engineering workshops can render more effective service than those who lack such experience; but there is much work to be done on machines which are so arranged that unskilled men—or women—can use them after very little preliminary training. The classes arranged in engineering laboratories will provide the necessary instruction to enable these persons to perform useful national work.

The laboratories of our universities, university colleges, and technical institutions are at the disposal of the Government, and in many of them men are devoting twelve hours a day to work in connection with the supply of munitions of war. A few days ago the members of the Royal Institution decided to offer the resources of their laboratories and of the Davy Faraday Research Laboratory to the Government for the prosecution of any particular research by officers of the Admiralty, War Office, or Ministry of Munitions; and the managers invited communication from these departments "in case there is any field of research in relation to or connected with chemical and physical science, or either of them, to which the professors, assistants, and staff of the Royal Institution or of the laboratory can usefully direct their attention with the view of giving assistance to his Majesty's Government in the conduct of the war."

We notice that this resolution was sent to the First Lord of the Admiralty, the Minister of War, the Minister of Munitions, and the chairman of the Inventions Board of the Admiralty, but we can scarcely suppose that each of these officers of State will act independently in making whatever use is possible of the offer. Mr. Lloyd George has announced in the House of Commons that he has made arrangements with the Secretary of State for War to take over the invention work relating to the munitions of war for the supply of which his department is responsible. He has also arranged with the First Lord of the Admiralty to take over the work relating to new expedients and inventions for purely Army purposes which are at present in charge of that department.

This action is in the direction of the establishment of the proposed central committee or bureau to direct scientific and inventive energy into channels of effective work. In his recent address to the British Science Guild, Sir William Ramsay described Lord Sydenham's scheme for the constitution by the Royal Society of a general advisory committee to which all Departments of State would be directed to apply for assistance in problems requiring scientific treatment and investigation. The Royal Society is already in close association with the Government departments, and has instituted helpful work on many problems relating to the war, but there seems to be a need for common action between it and other scientific societies, both as regards the preparation of a joint register and the co-ordination of consultative committees. When such an organisation has been established, it should not be in separate connection with the Admiralty, War Office, Ministry of Munitions, and Board of Trade, but with a bureau to which scientific suggestions or inventions would be addressed, with the sure and certain knowledge that they would be submitted to expert trial and judgment. It is not yet clear whether Lord Fisher's Board is to be this central body or whether further committees are to be established by other Government departments concerned with scientific problems of the war and munitions. Good organisation demands concentration of effort upon common problems; and that end will not be reached by separate departments and separate scientific societies appointing their own committees and panels of consultants for independent work and advice. Co-ordination might be attained by the constitution of a grand committee on which each department and each scientific society concerning itself with national work would be represented, or a sort of official exchange might be established to which all suggestions or needs would be communicated, either to be dealt with by a small scientific staff attached to it or distributed to expert advisers for judgment. Only by linking up the various departments with one another and with scientific societies somewhat in this fashion can overlapping be avoided and the fullest advantage be secured most expeditiously from the services which men of science are prepared to place at the country's disposal.

Most people assume that these services will be voluntary; and a correspondent directs our attention to the fact that in the forms circulated by the Physical Society in connection with the proposed "War Register," it is stated that: "It is to be understood that all service would be voluntary, and unpaid, being given for the good of the country during this period of emergency." He adds: "I should like to inquire how it comes about that the Physical Society is not in a position to offer remuneration for work of the character specified in the circular on a scale at least bearing a reasonable proportion to the wages paid by the Government for the performance of less responsible labour. Is it really for the good of the country that this work should be unpaid?"

Government departments and statesmen find their requests for expert advice and guidance re-

sponded to so willingly by scientific men and societies that they overlook the necessity of making any recompense for work done. In the medical services every qualified practitioner receives rank and reasonable pay, while consultants are given generous retaining fees. In legal circles also no advice is expected without a retainer is attached to it; and in this connection we are interested in the announcement that "according to a statement made in the House of Commons Sir John Simon, as Attorney-General, drew 18,000*l.* as his remuneration for the past year." It should be unnecessary to urge that the laws of nature are of as much importance as the laws of the land, and that as in the present crisis men of science can be of greater service to the nation than lawyers or politicians, they should receive at least sufficient reward for it to enable them to put aside their daily work in order to take up national duties. There will be no lack of volunteer workers among scientific men, but the State should understand that its responsibility for payment on account of expert opinion is at least as great in the case of science as it is in law, medicine, and engineering.

THE EVOLUTION OF THE GONIOMETER.

THE goniometer—as the instrument used for the measurement of the interfacial angles of crystals is called—has gradually developed from a simple and crude piece of apparatus to a refined and somewhat complex optical instrument, and the measurements made with it have become increasingly more accurate as the form improved, while on the other hand the methods of investigating the morphological characters of crystals have on the whole become simpler. Nicolaus Steno, who (in 1669) was the first to study the angles between the plane surfaces of crystals, laboriously determined them by slicing the crystals perpendicular to the edges bounding the faces in question, and outlining the sections on paper. The first instrument used for the purpose of measuring the interfacial angles is that known as the contact-goniometer, and was devised by Carangeot in 1783; it is used to this day for measuring large rough crystals. This type consists essentially of two arms, one movable with respect to the other, which are laid on the faces in question at right angles to their common edge; the position on a graduated scale of the end of the movable arm beyond the pivot gives the angle required. A cheap form of this type made in cardboard or celluloid was designed by S. L. Penfield in 1900. Accuracy to single degrees of arc is the utmost that can under the most favourable conditions be expected of the contact-goniometer.

To the ingenuity of W. H. Wollaston, in 1809, is due the reflective form of goniometer. In this type the common edge of the pair of faces under measurement is set in line with the axis of a rotatable graduated circle, and the position of the circle is read when some distant signal is reflected by the particular face in a predetermined direction; the circle is rotated, and the reading taken corresponding to the second face. The difference betwen the pair of readings gives the interfacial angle required. In the original form the graduated circle was vertical, and no means existed for fixing accurately the direction of reference. In a goniometer described shortly afterwards, in 1810, by E. L. Malus, a telescope of low power was used for receiving the reflections, and assuring, therefore, the constancy of the direction of reference, and in 1839 J. Babinet designed an instrument with a horizontal circle. E. Mitscherlich introduced many improvements and accessories in 1843; he added a collimator in place of a distant signal, and his screw arrangements for centring and adjusting the crystal are in principle the same as those generally used now. The horizontal-circle form of goniometer is extensively used at the present day, and the optical features and accessories have been brought to a high standard of perfection by the well-known firm of R. Fuess, of Berlin, who have devoted considerable attention to crystallographical instruments. Spider-lines were first used in the collimator, and afterwards the ordinary spectroscope-slit, but neither are satisfactory for goniometer work owing to the diffusion of the image on reflection at the tiny faces such as often occur on crystals. The difficulty was investigated by C. F. M. Websky, and in 1878 he described a slit, the jaws of which consisted of coplanar circular discs in contact, or nearly so, at the middle. This slit allows plenty of light to pass at the top and bottom, and the constriction at the centre admits of refined readings. In its original form, or slightly modified, this slit is universally used in modern goniometers. For the purpose of viewing the crystal while in position and determining what face gives a particular reflection, the telescope is usually supplied with a lens which is applied in front of either the objective or the eyepiece for converting it into a microscope of low power. In a well-made instrument, if the crystal reflections admit, readings may be made to 30 minutes of arc.

Various modifications of this type have from time to time been devised. In 1903 H. A. Miers used an inverted form, that is one in which the crystal is suspended below the graduated circle, for making observations on crystals growing in their mother liquor. He also designed a stage goniometer for the measurement of the optic axial angle of small crystal flakes under the microscope. More recently, in 1911, Dr. A. Hutchinson designed a convenient form of inverted goniometer for the study and measurement of tiny crystals or crystal fragments. In the universal goniometer (Fig. 1), as he terms it, the telescope A and collimator C are placed at some convenient angle to one another, and a microscope B is so arranged that its axis bisects the angle between them. The instrument may be used in the ordinary way as a goniometer, as an axial-angle apparatus (a fitting carrying nicol and condensing lens being placed for the purpose opposite the microscope), as a total-reflectometer of the Kohl-

rausch type (the crystal being immersed in a specially made tank containing a highly refractive liquid), and as a refractometer by the prism method (the telescope being removed and attached to the graduated circle, and the crystal-holder transferred to the rod used for bearing the tank-table).

It is obvious that in the case of a goniometer with a single circle only one zone of a crystal can be measured at a time. The difficulty of measuring with such an instrument a small, many-faced crystal is consequently very great, and there is grave risk of mistakes being made owing to tiny faces of similar appearance being confused. W. H. Miller, when measuring a complex crystal aggregate in 1874, was the first to recognise the advantage of defining the position of each face on a crystal by a pair of angular co-ordinates

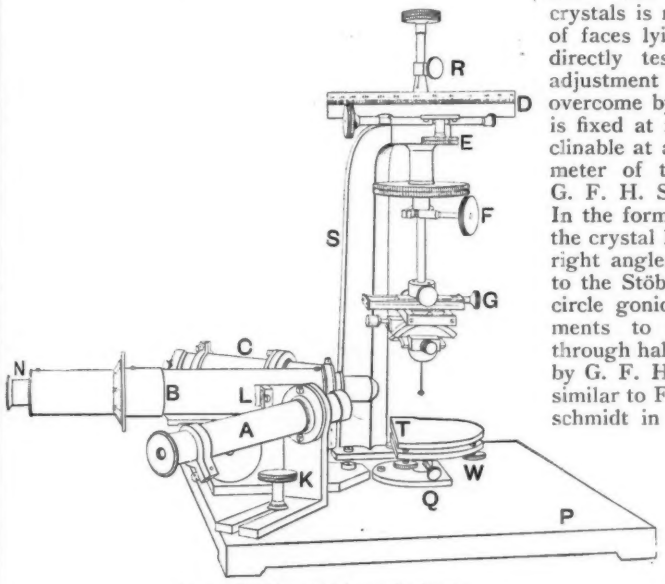

FIG. 1.—Hutchinson's Universal Goniometer.

analogous to the latitude and longitude of a place on the earth's surface—in the case of a crystal it is, however, more convenient to make the pole the origin of measurements—and thus avoiding the necessity of altering the adjustment of the crystal, at least during the measurement of one half of it. In this method a goniometer with two circles mutually at right angles is required. Miller merely clamped one goniometer with a vertical circle on to another with a horizontal circle; a brief description of the instrument was given in a posthumous paper (published in 1882 by his successor, Prof. W. J. Lewis, F.R.S.), but attracted little attention. Instruments on similar principles were designed by E. S. Fedorov in 1889, and V. Goldschmidt in 1893. A different pattern, in which the optical parts are movable about a horizontal axis, was designed by S. Czapski in 1893. F. Stöber in 1898 described a simple piece of apparatus consisting of a graduated circle, to which a crystal-holder was attached radially, for replacing the ordinary crystal-holder of the one-circle goniometer. This attachment has the inconvenience that in any position of the telescope the reflections from certain diametrically opposite parts of the crystal are obscured, and it is necessary to move the telescope through a measured angle; moreover, since the circle moves in so large a collar, accurate readings cannot be expected.

In the measurement of a crystal with a two-circle goniometer, if, as happens in the triclinic and sometimes in the monoclinic systems, a face of symmetry is not crystallographically possible at right angles to the edge of the zone of symmetry by which the crystal is adjusted, measurements are not made in zones, and consequently the most important property characterising crystals is not utilised. In any case the zonality of faces lying in or near cross zones cannot be directly tested on the instrument without re-adjustment of the crystal. The difficulty may be overcome by the addition of a third circle, which is fixed at right angles to the second, and is inclinable at any angle to the first circle. A goniometer of this type was described in 1899 by G. F. H. Smith, and in 1900 by J. F. C. Klein. In the form designed by E. S. Fedorov, in 1900, the crystal has two motions about axes mutually at right angles in large semi-circular collars similar to the Stöber circle already mentioned. A three-circle goniometer with modified optical arrangements to allow of continuous measurements through half a revolution in any zone was designed by G. F. H. Smith in 1904. An instrument very similar to Fedorov's was described by V. M. Goldschmidt in 1912.

CHEMICAL FIRE-EXTINGUISHERS.

THE article on "The Extincteur and its Limitations" in NATURE of June 3 described some practical points relating to the construction, tests, and use of portable fire-extinguishers now widely advertised and purchased. So much attention has been given to the article that a supplementary account of the chemistry of such extinguishers should be of equal interest and service. In putting out fire the chief things to be aimed at are the reduction of temperature and the exclusion of oxygen. Either will suffice if it can be obtained in a great enough degree, for combustion will not proceed if the temperature of the burning substance is lowered beyond a certain point; nor—apart from special cases with which we are not now concerned—can it take place in the absence of oxygen. In one class of the special preparations devised for use as fire-extinguishers the two effects are usually combined; in another class the second effect is chiefly the means relied upon to secure extinction of the fire.

Water charged with carbon dioxide is the commonest example of the first class. The water

cools down the burning mass, and itself becomes heated in the process, whilst the carbon dioxide expelled from the water by the heat displaces the atmospheric oxygen in the immediate neighbourhood, and both causes combine to stop the combustion. The larger extinguishers such as are usually supplied to public buildings are of this kind. They contain, typically, a strong solution of sodium carbonate and a charge of hydrochloric or sulphuric acid. The acid is kept separated from the carbonate until the apparatus is wanted for use, when by means of a breaking or overturning device the acid is mixed with the solution, and immediately liberates the carbon dioxide. The pressure of the gas forces the solution out of the apparatus, just as in the action of an ordinary "syphon" of soda-water.

Other aqueous solutions, frequently used in small extinguishers of the hand grenade type, contain chlorides instead of carbon dioxide. Apart from the water, these are considered to act as fire-quenchers partly by producing extinctive gases, and partly by coating the burning material with a non-combustible film. One formula for such a grenade, for instance, contains common salt and sal-ammoniac, another includes calcium and sodium chlorides, others contain chlorides of calcium and magnesium. Of similar type, too, are some preparations containing sulphites. Thus a solution of sodium sulphite and sal-ammoniac acts as a fire-extinguisher partly by giving off ammonia and sulphur dioxide, partly by the cooling effect of the water, and partly by coating the burning material with sodium chloride.

Of these small extinguishers it may be said in general that for quenching incipient small fires indoors they are useful, but too much should not be expected of them. The quantity of solution in a single extinguisher, or in half a dozen, is too small to be effective unless the fire is of quite restricted dimensions. Much of the quenching effect, it must be borne in mind, is due to the water; and though the chemicals enhance this effect, they do not multiply it to an unlimited degree.

For use more particularly in putting out fires of burning liquids such as petrol, kerosene, and other mineral and vegetable oils, which float upon the surface of water and so may be spread by the latter, extinguishers containing dry powders are sold, and also others composed of non-aqueous liquids. The powders generally include carbonates or bicarbonates, with or without an admixture of chlorides. One much advertised article, for example, consists of a mixture of calcium carbonate and sodium bicarbonate. Their action depends chiefly upon the evolution of carbon dioxide and other gases, under the influence of heat. Like the hand grenade class, these extinguishers are in general effective only with small fires, and not in all circumstances. For example, a film of burning liquid might be extinguished readily by a covering of one of these powders, whereas the powder thrown on a thick layer of the liquid might fall to the bottom and remain practically unaffected, at least until the oil had burnt down to its level.

Of the non-aqueous liquids employed the chief appear to be chlorinated hydrocarbons. They are probably mixtures of several members, but approximate more or less closely to tetrachloroethane, or to mixtures of this with carbon tetrachloride. These depend for their effect upon the production of extinctive gases when heated, and one disadvantage of their employment is the evolution of fumes, copious and unpleasant, consisting of hydrogen chloride. For use on small petrol fires, and also on small quantities of ignited inflammable materials, such as celluloid and carbon bisulphide, they appear to be reasonably efficacious. For larger fires, especially of loose combustible substances such as straw, paper, shavings, and the like, they are of much less value. Extinguishers of this class have thus a special and limited usefulness rather than general applicability to ordinary conflagrations. In fact with these as with all extinguishers, it is well to remember that whilst the prompt application to a small incipient fire may be effective, it is quite another matter when a big blaze has been allowed to develop.

THE SURGERY OF THE WAR.

WE are familiar, by this time, with the saying that the War has brought "Listerism" back for the treatment of our wounded. Not that the use of antiseptics had ever vanished out of practice: but the aseptic method—the sterilising, by heat, of almost every appliance of surgery—had come into general use, and had been reckoned as a great improvement on the antiseptic method. It had seemed a safer, more natural, more scientific way of operating. And in civil practice it is, indeed, well-nigh perfect. It is "the ideal method." That is to say, it would be perfect if all surgeons, nurses, and patients were perfect. But it is not so simple as it sounds: and some surgeons, perhaps, have so admired the pursuit of the ideal that they have been tempted to think of Lister's work as a mere "stage" on the way to their own. Then came the War; and, at once, surgeons had to face a condition of wounds very different from the clean-cut incisions made in the formal operations at placid, well-appointed hospitals and nursing-homes over here. This overwhelming multitude of shell-wounds and shrapnel-wounds, infected right away with mud and sweat and particles of clothing, and with all the germs of heavily manured soil, must be disinfected, if that were possible, with antiseptics. Thus, there has been that return to the antiseptic method which Sir Rickman Godlee described, a few months ago, in his lecture at the Royal Institution.

But this return to Listerism reminds us of Mme. de Staël's wise saying, "L'esprit humain fait progrès toujours, mais c'est progrès en spirale." If we are indeed back at Lister, we are back at a higher level. It is exactly half-a-century since he, in Glasgow, in 1865, first plugged the wound of

a compound fracture with a strip of linen soaked in coarse, impure, undiluted carbolic acid. What came of that experiment the world knows, and is not yet tired of knowing. But he could not then foresee the wealth of new discoveries which followed, incessantly, this first method of dealing with "germs of putrefaction." Least of all could he foresee the swift rise of bacteriology, its extension over the whole art and science of medicine and surgery, and its magnificent achievement of protective treatments, antitoxins, and vaccines. But he lived to see them, and to help to make them possible. We are likely to have in our hands, before many months, the final and authoritative record of his life and of his work. It will be a book worth waiting for, and it will be, even in these hard times, a book worth buying.

Meanwhile, for all who love to read of surgery —and who does not?—there are two admirable lectures by Keen of Philadelphia, entitled "Before and After Lister." They were given to the United States Army Medical School a few weeks ago, and are published in *Science*, June 11 and 18. They have much to say of military surgery, past and present, and they say it very well. There is also a very striking article in the *Times* of June 28, on "Wounds and Blood-poisoning," and on the present work of Sir Almroth Wright at Boulogne. The lectures and the article, between them, give us a good insight into the *progrès en spirale* of surgery, from 1865 to 1915.

NOTES.

IT was announced on July 5 that Admiral of the Fleet Lord Fisher of Kilverstone had been appointed chairman of the Inventions Board established to assist the Admiralty in co-ordinating and encouraging scientific effort in relation to the requirements of the Naval Service. The arrangements for the organisation of the Board have now been completed. It will comprise:—(*a*) A Central Committee; (*b*) a Panel of Consultants composed of scientific experts who will advise the main Committee on questions referred to them. The Central Committee will consist of:—Lord Fisher of Kilverstone, G.C.B., O.M. (president), Sir J. J. Thomson, O.M., F.R.S., Hon. Sir C. A. Parsons, K.C.B., F.R.S., Dr. G. T. Beilby, F.R.S. The Consulting Panel will comprise the following list, which will be added to from time to time as necessary:—Prof. H. B. Baker, F.R.S., Prof. W. H. Bragg, F.R.S., Prof. H. C. H. Carpenter, Sir William Crookes, O.M., F.R.S., Mr. W. Duddell, F.R.S., Prof. Percy Frankland, F.R.S., Prof. Bertram Hopkinson, F.R.S., Sir Oliver Lodge, F.R.S., Prof. W. J. Pope, F.R.S., Sir Ernest Rutherford, F.R.S., Mr. G. Gerald Stoney, F.R.S., Hon. R. J. Strutt, F.R.S. The Board is accommodated temporarily in the Whitehall Rooms, Hotel Métropole, Whitehall Place, S.W., but at an early date (which will be announced in due course) it will be transferred to permanent offices at Victory House, Cockspur Street, S.W. Communications should be addressed to the secretary, Board of Invention and Research.

WE regret to announce the death in action on the western front, on Saturday, July 10, of Lieut. Ernest Lee, a young botanist of considerable promise, who had already published some excellent work, notably a paper in 1911 on leaf-fall. Lieut. Lee obtained a national scholarship in 1906, and while at the Royal College of Science, South Kensington, was both Marshall scholar and Forbes medallist. He was an associate of the Royal College of Science and a fellow of the Linnean Society. In 1910 he became assistant lecturer in the botanical department at the Birkbeck College, London, and in 1913 went to the University of Leeds as a lecturer in agricultural botany. He there became a member of the Leeds O.T.C., and obtained a commission in the Duke of Wellington's Regiment soon after war broke out. In the autumn of 1914 he married Miss H. S. Chambers, lecturer in botany at the Royal Holloway College. Lieut. Lee was killed instantaneously by a bullet while with his guns, and he will be greatly regretted by all who knew him or his work.

LAST week we recorded with regret the death, at the age of twenty-seven, of Mr. H. S. Bion, assistant superintendent of the Geological Survey of India. Mr. Bion was born in India, and was educated at the School for the Sons of Missionaries at Yvesdon House, Blackheath, and at University College, London. His university career was a distinguished one. In 1905 he obtained the university scholarship in geology, and in 1906 the Morris geological prize. In 1908 he took the degree of B.Sc. in the University of London, obtaining first-class honours in geology. In 1911 he was elected a fellow of the Geological Society. In February, 1911, he joined the Geological Survey of India, and in the following November he was appointed curator of the museum and lecturer in the Presidency College, Calcutta. His work in the field was chiefly in Burma and Kashmir, and he did particularly valuable work in the latter area, especially among the Carboniferous rocks. His marked ability, his unselfish character, and scientific enthusiasm, endeared him to all with whom he came in contact, and his untimely death is deeply regretted by his former teachers in this country, his colleagues of the Indian Survey, and his numerous friends.

BY the death of Mr. R. W. Raper, fellow, vice-president, and bursar of Trinity College, the University of Oxford has suffered a serious loss. For some time his health had been failing, but the news of his sudden decease has come as a shock to his friends in Oxford, who had seen him walking about as usual up to within a very recent period. Mr. Raper was one of the best known and most highly respected of Oxford residents. His services to his college were of great value. The combination of clear-headed business aptitude, firmness in action, and humorous but not unsympathetic methods of dealing with difficult situations made him an almost ideal college bursar. Countless undergraduates have good cause to remember his generous friendship and refined hospitality. As a promoter of public interests he did a great work, both in his University and in his paternal home at Malvern. Oxford holds in especial gratitude his

action in defending the top of Shotover Hill from enclosure. The preservation of beauty, whether in nature or in art, always found in him an enthusiastic champion.

HERBERT KYNASTON, whose death was recorded in our issue for July 15, was the son of the late Dr. Kynaston, Canon of Durham, and was born on July 19, 1868. He entered King's College, Cambridge, making a special study of geology, and securing a first class in part ii. of the Natural Sciences Tripos in 1891. He proceeded to examine the volcanic rocks of Old Red Sandstone age in the Cheviot Hills, and was appointed an assistant geologist to the Geological Survey (Scottish Branch) on May 3, 1895. His first official work lay among the Old Red Sandstone rocks of Lorne and Glencoe, and he made important contributions to the Memoirs on Mid-Argyll and the Oban and Dalmally districts. He resigned his post in January, 1903, to take up the difficult duties of director of the reconstituted Geological Survey of the Transvaal, and numerous members of the British Association will recall his kindly guidance during a memorable visit to South Africa in 1905. The first report under his auspices, that for 1903 (see NATURE, vol. lxxi., p. 53), contains a paper by him and his colleague, A. L. Hall, on diamond-bearing pipes and alluvial deposits. He described in later reports the Komati Poort coalfield and the tin-deposits of Waterberg, south of the Limpopo, and much of his work had to be carried on in advance of the mapping of the country. When, under the Union Government, the Geological Surveys of the provinces were united, Kynaston was selected as director, and he initiated the series of Memoirs of the Geological Survey of South Africa. His death at Pretoria on June 28, 1915, at the early age of forty-six, will be regretted as much in Scotland as in South Africa, and some of his observations on the Glencoe area are embodied in a memoir that is still passing through the press. One of his colleagues writes of him with simple feeling as a man who was "a true friend, of quiet disposition, but full of kindly humour and affection."

WE learn from *Science* that Dr. Viktor von Lang, emeritus professor of physics at Vienna, has been elected president of the Vienna Academy of Sciences. The academy has elected as corresponding members Dr. Sven Hedin, Dr. Max Planck, professor of mathematical physics at Berlin, and Dr. P. H. von Groth, professor of mineralogy at Munich.

THE Livingstone gold medal of the Royal Scottish Geographical Society has been awarded to Lord Kitchener in recognition of his work on the survey of Palestine, and as a director of the survey of Cyprus, as well as in recognition of his signal services to the State. The society's gold medal has been awarded to Dr. J. Scott Keltie, late secretary of the Royal Geographical Society, in consideration of his services to geographical science.

WE regret to record the death on June 18 of Mr. T. D. West, at Glenville Hospital, Cleveland, Ohio. *Engineering* for July 16 contains a brief account of his career. Mr. West was born in Manchester in 1851; his parents emigrated to the United States when he was an infant. He entered a foundry at the age of twelve, and was connected with foundry work throughout his life; he was a recognised authority on subjects pertaining to foundry work. At the time of his death he was chairman of the West Steel Casting Co., Cleveland. He was a member of several American societies, and was the author of several books and pamphlets on foundry practice.

THE annual meeting of the general committee of the Imperial Cancer Research Fund was held on Tuesday, July 20, Sir William Church in the chair. The work of the fund has been greatly curtailed owing to the war, and the scientific part of the annual report is restricted to a summary of the work published during the year. The work comprises an experimental study of metastasis, which emphasises the importance of the processes at the site of arrest of tumour emboli, an investigation into immunity to transplanted sarcomata extending the well-known findings with regard to carcinoma to the connective tissue tumours, and biochemical studies. The two biochemical papers deal with the action of ferments. The first is concerned with the effect of minute alterations in the reaction of the medium on the activity of a maltose hydrolysing ferment. The second deals with the action of the protein-splitting ferment present in normal serum of man and animals as accounting for the phenomena comprised in the Abderhalden serum reaction. The conclusion is drawn that the doctrine of specific protective ferments set up by Abderhalden is unsound, and that the reaction even in its improved form cannot be relied on for the serum-diagnosis of pregnancy or cancer. The report also discusses the pathological bearings of the new and interesting data in the Registrar-General's Report for 1913 on the influence of marital condition in women on the mortality from cancer of organs special to their sex.

THE *Engineering Magazine* for July contains an interesting article on war orders and their effects on American industry. Sales of benzol have been much stimulated by the war, and the price has been quintupled. American makers of explosives have had two problems to solve, first, to expand their plants; secondly, to change over their processes to make foreign powder. These, together with the problem of securing a sufficient supply of raw materials, such as benzol, have been pretty well solved, and the production of explosives is proceeding on a tremendous scale. Many makers who have undertaken orders for shells have made heavy purchases of machine tools for executing the orders; these firms have been unwilling to fill their existing plants with such special work at the expense of inconveniencing their regular customers. Evidently these firms are looking for a strong revival in domestic demands. The Westinghouse Electric and Manufacturing Company, after accepting a large order for rifles, bought two plants—the Stevens Arms Company and the Stevens-Duryea Automobile Company—in order to take care of the work outside of its Pittsburgh plants. Mr. J. F. Wallace, formerly chief engineer of the Panama Canal, thinks that, as

a consequence of the huge orders placed, the United States will have the means of providing for national defence; the plants now used for supplying European requirements could be used to equip home armies in a remarkably short time. In other words, the United States has obtained insurance against attack for practically nothing, so far as equipment preparation will provide.

IN the July issue of *Man* Mr. E. J. Wayland describes a series of stone implements collected by him on the Monapo river in the Portuguese province of Mozambique, East Africa. All, with one possible exception, are extremely crude, being chipped out of nodules of chalcedony and jasper with which the basalt ridges of the sedimentary coast belt are bestrewn. There is no certainty about their age, the fact that they are found on the surface not necessarily showing that they are of comparatively modern date. They closely resemble those found by Mr. Lamplugh near the Victoria Falls. No local evidence justifies their attribution to a period earlier than the early Palæolithic, but they may be of much later date.

IN *Man* for July Dr. W. H. Rivers describes specimens of the boomerang found on the coast of Espiritu Santo, New Hebrides. They differ from the Australian type in having the ends almost square or showing a slight curve not continuous with the general curvature of the implement. The antiquity of the use of the boomerang in the New Hebrides may be assumed from its connection with tribal rites, and one group claim descent from it. This discovery raises an important problem. The weapon is generally regarded as an ancient element in Australian culture, but Dr. Rivers suggests that it was introduced by the race which, in his studies on Melanesian social life, he calls the Kava people. The discovery is, he thinks, sufficient "to put us on our guard concerning the supposed antiquity of the Australian boomerang, for in spite of their difference of form, there can be no reasonable doubt that the Australian and Melanesian instruments are but divergent manifestations of the handiwork of one people."

IN his presidential address to the Royal Society of South Africa (May 19) Dr. L. Péringuey summarised the conclusions he has reached regarding Palæolithic man in South Africa. He still maintains that the early Palæolithic cultures—Chellean, Acheulean, and Mousterian—which occurred in sequence in Europe, existed together in South Africa. The later Palæolithic cultures, particularly the Aurignacean and Solutrean, are richly represented in South Africa, where they are associated, as in Europe, with a particularly realistic form of art. The evidence which associates the later Palæolithic cultures with the ancient Bushman is, in Dr. Péringuey's opinion, now quite complete. He endeavours "to show that the Bushman, if himself not the ancestor of those Solutrean and Aurignacean people, may have been of them, and that he has retained many parts of their handicraft is equally certain." Dr. Péringuey is prepared to believe that the later Palæolithic cultures of Europe were introduced from South Africa.

THE Hydrachnidæ, or water-mites, are favourite subjects of study for students of "pond-life." Such students are indebted to Messrs. W. Williamson and C. D. Soar for an illustrated account of the genus Lebertia, which appears in the Journal of the Quekett Microscopical Club, vol. xii., No. 76.

A RECENT number of the *Philippine Journal of Science* (vol. ix., section D, No. 4) is almost filled by an exhaustive account of the Palæmons of the Philippines by Dr. R. P. Cowles; a feature of the paper is the careful series of measurements of the segments of the chelate thoracic limbs in the various examples of each species described.

DR. A. RANDELL JACKSON, whose studies in British spiders are well known, has published (Proc. R. Phys. Soc., Edin., vol xix., No. 7) a "Second Contribution to the Spider Fauna of Scotland." This includes a Clubiona, hitherto undescribed, and several species not before found in Great Britain. As might have been expected, Ben Nevis and the Cairngorm group of summits proved exceptionally good collecting grounds. But why does the author write "Ben McDhui," as if the famous Aberdeenshire mountain were named after a Highland clan, instead of preserving the original "Ben Muich Dhui" (="Mount of the Black Hog")?

MANY marine animals of high interest have been made known through the activities of the Irish Fisheries Surveys. Some new light on the life-history of echinoderms has been shed by larvæ dredged or tow-netted off the south-west coast of Kerry, and described by Dr. J. F. Gemmill (Proc. R. Phys. Soc. Edin., vol. xix., No. 7). A single Brachiolaria larva, resembling that of *Asterias rubens,* is carefully figured; it was taken in a tow-net at 1150 fathoms' depth. An advanced bipinnaria stage, found in five different localities, and referred to *Luidia ciliaris,* is also described and drawn.

ORNITHOLOGISTS may turn with profit to some "Notes on the Moults and Sequences of Plumage in Some British Ducks," by Miss Annie C. Jackson, which appear in the July issue of *British Birds,* for there are yet some who hold that a colour change without a moult is not only possible but demonstrable, a conclusion based on an inability to weigh evidence and a want of knowledge of the structural peculiarities of feathers. But the merit of Miss Jackson's paper lies not so much in controverting these fallacious arguments as in establishing the fact that female surface-feeding ducks undergo a complete moult in the spring. This moult extends also to the underclothing of down-feathers. But by far the most important item in her work is the discovery that at this spring moult an additional form of down, longer and coarser, is developed, apparently to serve as a lining for the nest. Presumably this peculiar type of down is developed on the breast alone. Further particulars of the structural peculiarities of this down, which disappears with the autumn moult, would be acceptable.

A VERY useful summary of what is known in regard to the emission of light among insects is given by Mr. K. G. Blair in the Proceedings of the South

London Entomological and Natural History Society, 1914–15. Original observations, made by the author himself, add materially to the value of this contribution. Originally, it is assumed, developed as a protective device against enemies—the light-emitting qualities being associated with, or perhaps the cause of, nauseating properties—luminosity has become primarily a secondary sexual character. This much is attested by the response which can be obtained by experiment from the use of small electric bulbs. These experiments conclusively show that each species has its own characteristic method of exhibiting its light, and that an individual from any one species will, as a rule, only respond to, or evoke an answering flash from, a member of the opposite sex of that species. Some species, moreover, respond more readily to artificial flashes than others. Some will even answer the flash of a match. Luminosity in some cases, however, seems to play a directly utilitarian part, as in the case of the fly *Thyreophora cynophila*, which is said to be nocturnal in habit, and to feed on dead bodies by the light of its phosphorescent head. Finally, the author discusses numerous instances of pathological luminosity due to luminous bacteria, as in the cases of certain midges and crustacea.

STUDENTS of genetics, no less than systematists, will welcome the "Review of the South American Sciuridæ," by Mr. J. A. Allen, which appears in the Bulletin of the American Museum of Natural History, vol. xxxiv., 1915. In discussing the value of size as a "group character," the author remarks that closely related forms present a small average range of variation, *inter se*, and a very wide range of individual variation. Specificity is determined, not by individuals, but by groups of individuals. In attempting to discover tangible differences in the form of the skull and the character of the teeth in American squirrels, with a view to their use as the basis of generic or subgeneric divisions, some surprises were met with in respect to the variability of such features in specimens of the same species from the same locality. The form and the details of the crown pattern of the last premolar and the last molar were found to be extremely unstable features. The author also makes some extremely interesting observations on colour variations and the evolution of new types of coloration.

FROM the Department of Agriculture, Ceylon, have been received Bulletins Nos. 12, 13, and 14, dealing with Hevea tapping results at the experiment station, Peradeniya, the tapping of an old Hevea tree at Heneratgoda, and manuring of cacao at Peradeniya respectively. The old Hevea tree is apparently one of the original trees sent out from Kew in 1876, and its girth in August last was 117 in. at 3 feet from the ground. The tree has been tapped with short intervals over a period of 4 years 9 months, and the total yield of rubber has been 392 lb. 7 oz.

THE Polyporaceæ of Wisconsin form the subject of Bulletin xxxiii. of the Wisconsin Geological and Natural History Survey. This great family of fungi, which has been worked out by Mr. J. T. Neuman, is represented in Wisconsin by a great number of species, and Cyclomyces is the only genus unrecorded. The bulletin consists of 148 pages of descriptive text with twenty-five plates of figures, which should enable the fungi to be easily identified. As many of the Polyporaceæ are serious timber-destroying fungi the book should prove of value in the United States. Of the destructive forms, *Polyporus abietinus*, *P. pergamenus*, growing on maple, willow, oak, etc., *Trametes pini* and *Fomes ungulatus*, cause the greatest damage to timber trees.

WE have received a copy of a new publication entitled "Egyptian Agricultural Products," published by the Ministry of Agriculture, Egypt, dealing with *Sorghum vulgare*, Pers., the great millet and its varieties, and also with *S. halepense*, Pers. The account, No. 1A, 1915, has been compiled by Mr. G. C. Dudgeon, consulting agriculturist to the Ministry of Agriculture, Egypt. Botanical descriptions of the types and the varieties are given, followed by details of the history of the great millet in Egypt, and full cultural details. It seems probable that *S. halepense*, which is indigenous in Egypt, is the plant from which *S. vulgare* and its numerous varieties have been evolved. The uses of the grain and the leaves are also dealt with, and the question of the poisonous character of the young leaves is discussed. When grown under dry conditions the young leaves appear to be more poisonous than when grown moist, but as the toxic properties are destroyed by heat the precaution is always taken of exposing young leaves to the sun for some time before feeding them to cattle. When mature the leaves afford a safe cattle food.

THE first volume of the Agricultural Statistics of India (1912–13) is particularly valuable on account of the new features, which include charts, summary tables, and a comprehensive introductory report. The charts indicate considerable progress since 1901, and the increased acreage devoted to cultivation has been accompanied by an improved yield in the crops. The decline in the acreage devoted to indigo and opium continues; and the minor fluctuations in area under the other crops are shown to be largely due to rainfall deficiencies. In a comparative statement it is shown that India has under rice more than eleven times the area of the paddy fields of Japan, that India is the third country in the world in regard to acreage under wheat, since there is under that cereal three times the Canadian area and three-fifths that of the United States, that India has the largest acreage under maize outside the United States, and that the area under cotton in India is three-fifths that of the United States and twelve times that of Egypt. This issue may be regarded as the first of a new series of annual reports.

AN important contribution to the geography of Canada has been made by Mr. J. B. Tyrrell, of the Geological Survey, in a paper reprinted from the Transactions of the Royal Canadian Institute, Toronto, entitled "Algonquian Indian Names of Places in Northern Canada." In the course of fifteen years' service in that region Mr. Tyrrell made extensive inquiries from natives regarding the original names of the chief physical features in the Cree and Ojibway

languages. He gives a long list of the native names with those now current. In some cases the native name has been preserved with more or less modification; in others it has been replaced by a translation into English; in others, again, it has been replaced by a purely English designation. Thus a place which in the native tongue was called by a name meaning "A Hole through the Earth," has become "Oxford Lake." The native terms now recorded throw welcome light on the proper pronunciation of geographical terms. It is to be hoped that these names will now be systematically recorded before they finally disappear. Such lists may supply some information on Indian tribal history before the entry of Europeans into the country.

ALTHOUGH the genesis of the various thirty-two systems of crystallography has formed the subject of numerous writings at the hands of Hauy, Brocke, Bravais, Schoenfliess, and others, a suggestive note contributed to the *Atti dei Lincei*, xxiv., 7, by Dr. C. Viola throws new light on several portions of the subject. Instead of basing his classification on symmetry, he classifies the principal six systems by means of the properties of zones normal to faces, proving the following theorems:—A plane of symmetry is a face and is normal to a zone; an axis of symmetry is a zone, and is normal to a face; a zone which is normal to a face is necessary for the existence of a plane of symmetry or of a symmetrical or specular axis; two zones normal to faces and inclined to each other involve the presence of a zone orthogonal to them, and as many zones normal to faces as there can be in their common plane; two orthogonal zones normal to faces involve the existence of a third, and only a third, zone normal to a face; three zones normal to faces inclined to each other are sufficient and necessary conditions that every face should be normal to a zone. These theorems establish the existence of the following systems: triclinic, monoclinic, trimetric, dimetric, hexagonal, and monometric. It is pointed out that similar methods are applicable to investigate the properties of systems other than crystals.

MR. W. THOMSON described to the Manchester and Salford Sanitary Association on July 6 an ingenious method for obtaining a dust and smoke record. A hollow brass cylinder has a small slit cut in the side over which a ribbon of filter paper is stretched, whilst the air is passed through the paper by exhausting the interior of the cylinder. After a half-hour's exposure the ribbon is automatically moved on and a fresh surface exposed. In this way the fine dust and smoke are deposited in rectangular patches at half-hour intervals, and the depth of colour produced can be used as a means of comparison over any desired period. It appears that in Manchester, where the investigation was carried out, the atmosphere is most polluted on Mondays and Tuesdays and least on Sundays.

PART 3, vol. v., of the Journal of the College of Agriculture, Tokyo, is almost entirely devoted to mycological researches, and it forms a very important addition to the literature on the subject. With one exception the papers are printed in English, and it is to be hoped that one desirable result of the present disastrous war will be the spread of English in preference to German in the scientific literature of Japan. The papers are illustrated with plates of great accuracy and beauty, which testify to the care with which the investigations have been performed. Indeed, they would appear to rank with those carried out in the famous Carlsberg Laboratory of Copenhagen. It is interesting to note the developments caused by the intrusion of chemistry into mycology—the Saccharomyces are characterised to-day as much by their selective behaviour towards various carbohydrates and amino-compounds as by their morphological characters.

FERMENTED beverages have always been the hunting-ground of the mycologist, and the majority of the known species have been obtained from this source. The beverages of the Far East are quite peculiar in the nature of their ingredients, and experience has demonstrated that they contain a unique flora of Saccharomyces. The latest Chinese beverage to be studied is "Shaoshing-chu," of which very large quantities are manufactured in the province of Chü-Chiang. Mr. Takahashi describes (Journal of the College of Agriculture, Tokyo, vol. v., p. 200) several varieties of *Saccharomyces shaoshing*, a new species of yeast analogous to saké yeast, as well as four new forms of a *Zygosaccharomyces shaoshing*. The same number of the journal describes the budding fungi of a beverage made from a mash of steamed soy bean and roasted wheat. Five different Zygosaccharomyces were isolated. The assimilation of amino-acids from their pabulum by these yeasts is studied in detail, and the interesting fact established that it is materially smaller than in the case of saké yeast. Another Japanese beverage of which the soy bean forms the basis is "Hatsuchō-miso." This generally takes from three to five years to ripen, and is highly valued on account of its special aroma and taste. A preliminary investigation of the fungi present and the chemical changes occurring during the ripening indicates that the quantity of amino-acids present in the mash is an important factor, and there is a probability that such work will lead to the improvement of the product.

OUR ASTRONOMICAL COLUMN.

A BRIGHT METEOR, JULY 17.—A brilliant, swift meteor (=Venus) was observed by Mr. H. E. Goodson at the Hill Observatory, Salcombe Regis, on July 17, 10h. 54m. p.m. G.M.T. The path practically crossed δ Scorpionis, and was directed towards 42 Librae. The trail, about 3° long, persisted several seconds.

THE DETERMINATION OF EASTER DAY.—Anyone who desires a clear and simple account of the principles on which the determination of Easter Day depends may be recommended to consult a paper by Dr. A. M. W. Downing, which was read before the Victoria Institute on March 15 of this year. The problem involves the combination of the three incommensurable periods, the week, the lunar month, and the tropical year, and has been further complicated by changes in the calendar. The way in which the adjustment has been effected to comply with the primitive ecclesiastical rule is here explained in untechnical language and with much interesting historical detail. A discussion of the more comprehensive mathematical rules, like that of Gauss, would have been outside the scope of the paper, which deals rather with the construction and use of

the Prayer Book tables. Some account is also given of the Jewish calendar, with some reference to the astronomical evidence bearing on the date of the Crucifixion. The paper was followed by a discussion, which is reproduced with it.

Dr. Downing expresses himself in favour of making Easter Day a Sunday in a fixed week, remarking that the lengthy explanations required by the present system make a strong argument in favour of this course. But, as he admits, no change is feasible which does not carry with it universal agreement. It is a little difficult to appreciate the opposition to a fixed Easter, which found expression in the discussion following the paper. The association of ecclesiastical festivals with certain astronomical conjunctions is intelligible, even if it fails to carry sympathy. But this is precisely what the present artificial rules do not secure, a fact illustrated in the year 1905, alluded to by Dr. Downing, when Easter Day fell four weeks later than it should have done according to the real moon, and also by the complete variance between the Eastern and the Western churches. The opposition between religious sentiment and practical convenience would probably change in form if, instead of suggesting a fixed Easter, it were proposed to fix the dates of all public holidays, and so to dissociate them from all religious observances.

CEPHEID-GEMINID VARIABILITY.—In the *Astrophysical Journal* (vol. xli., No 4, pp. 307–14) Mr. C. D. Perrine brings forward a tentative explanation of this type of stellar variability based on an inquiry into their orbital characteristics, etc. Discussion of data regarding thirteen stars indicates that the conditions requisite for the production of such variables are large eccentricity combined with small distance between components and small mass of secondary. The few cases of F- and G-type stars other than the variables in question with similar masses of secondaries and orbital dimensions have small eccentricities and show no variation in brightness. It is therefore suggested that the variation of light is caused chiefly by changes in the light of the *secondary* due to disturbance in the part of its orbit near periastron, the maximum of light occurring at about the time of maximum approach of the primary.

VARIABLE STARS.—A series of notes and data dealing with various subjects related to stellar variability is contributed by Dr. Harlow Shapley to the *Astrophysical Journal* (vol. xli., No. 4, pp. 291–306). Some of the observational work was carried out at the Princeton University Observatory, but the material was worked up at Mount Wilson. Using the bolometric observations of the Astrophysical Observatory of the Smithsonian Institution, Dr. Shapley has been able to investigate the darkening towards the limb of the sun in comparison with the similar darkening revealed by the study of eclipsing binaries. It has now been found that, although the empirical formula adopted at Princeton in the case of eclipse variables does not completely represent the solar darkening, the agreement is nevertheless quite close, the error being generally less than 1 per cent. It is also found that the darkening coefficient varies with the number of sun-spots, more especially for light of shorter wavelengths; a variable darkening coefficient is thus suggested. Another note contains some interesting conclusions regarding the periods and spectra of close binary stars. The data employed by Wicksell in a similar investigation has been legitimately extended by the inclusion of eclipsing variables. Cepheid variables were, however, eliminated, Dr. Shapley having come to the conclusion that they are not binary systems (see NATURE, vol. xciv., p. 572). Thus modified, the data does not show the secondary maxima of period found by Wicksell, except in the case of B-type stars. The maximum number of periods are between 2·5 and 6 days. Other notes deal with variable stars U Pegasi, *o* Persei, R. Canis Major, and AE Cygni, and the number of naked-eye variables.

THE SOCIETY OF CHEMICAL INDUSTRY.

THE Manchester meeting of the Society of Chemical Industry on July 14–16 was by far the most important gathering of chemists since the commencement of the war, and its success augurs well for the future of the society. Hitherto the annual meetings have been largely of a social character, and though they have served a valuable purpose in promoting personal friendships, it has been widely felt that the society has not taken full advantage of the opportunities for the discussion of industrial problems which the annual meetings provided. It was obvious this year that social functions were entirely out of place, and the organising committee devoted their efforts to securing discussions of matters of prime importance to British chemical industry.

At all the sittings, and still more in the general conversations, there was a consensus of opinion that the time had come for the society as a body to take active action in regard to these matters. The gathering was a representative one, and was largely attended by the industrial chemists of the Manchester and Liverpool districts, and also by those further afield, in spite of the calls on their time made by war work. The academic element was very well represented, a noticeable feature being the presence of many of the professors recently appointed to act in a consultative capacity to the national dye scheme. Although visits to chemical works did not form part of the official programme, there was marked evidence on the part of manufacturers to oblige in this respect, showing that the need of greater co-operation amongst our chemical industries to meet foreign competition was not overlooked.

The themes underlying all the papers, as well as Prof. G. G. Henderson's presidential address, were the same—the need of closer co-operation between the manufacturer and the chemist, and the necessity of improving the training, not so much of the would-be chemist, as that of the managing classes of the community so as to bring about a better appreciation of what science and scientific method really are, and how they can be turned to practical account. Not less important is the necessity of organising industrial chemists as a whole, so that they can speak authoritatively and with a certainty of being heard in the counsels of the nation.

The discussions were to the point, and were brief, largely because the meeting was in entire agreement with the suggestions before it. A greater public participation in them by the representatives of industry might have produced new facts and suggestions, and the president should have made a more direct appeal on these grounds. Judging from what was said in private, the view-point of the man engaged in industry is imperfectly appreciated by the professor, and as the latter is more generally heard on the public platform, there is a danger of the practical side of the issues being insufficiently represented. This is particularly the case in regard to the many committees appointed in connection with the war, on which the chemical manufacturer is very inadequately represented.

Prof. Henderson, in his presidential address, considered that the comparative failure of chemical industry in this country was due to the lack of appreciation of research, to the absence of co-ordination between manufacturers and professors of chemistry, and especially to the lack of provision for enabling men of academic training to apply their knowledge to indus-

try. This last is undoubtedly one of the greatest difficulties, and to meet it he advocated a scheme of industrial fellowships on the lines of that introduced in America by the late Prof. Kennedy Duncan. A discussion on this point would have been illuminating, as there is no doubt that in the opinion of the manufacturer much of the product of the modern university training is disappointing. The excessive devotion to physical and theoretical chemistry, an insufficient knowledge of general chemistry, poor manipulative power, and lack of ability to tackle even simple problems are the common defects in their training, and if, as is usually the case, these manifest themselves after the newcomer has been taken into the confidence of the firm, the result is to shake the confidence of manufacturers in the university chemist. The ability of the chemist to take charge of a process is a natural rather than an acquired gift, but it is essential if the works chemist is to make material progress in the scale of promotion, as it is only the largest firms which can afford to maintain a large staff of highly-paid research chemists.

Dr. M. O. Forster also emphasised the chasm between the college and the factory as responsible for much mischief, and would appear to put the blame largely on the factory. It is a pity that a further paper on this subject was not secured from a responsible person in one of our largest chemical works, as there is a strong counter-feeling prevalent that the college and the scientific societies, by holding aloof from the factory, tend to place industrial chemists on a lower plane in the profession, and debar the most gifted students from entering the factory.

An address by Prof. H. E. Armstrong dealt with the need of organisation within the industry for the purposes of development and the protection of the interests of industrial chemists. He emphasised particularly that chemistry had not attracted the right stamp of man—one of generous mind, good presence, and real ability—in sufficient numbers. They looked to the older universities, particularly to Oxford, to supply this type, whereas the universities, owing to their neglect of the science schools, encouraged their graduates to take up law, mathematics, or classics. Such material would be worth, and would command, good pay when properly trained. The desire for a scientific vocation must begin in the schools, and schoolmasters must encourage their best pupils to this end instead of advocating classics, because the immediate prospect of scholarships at the university was greater. The success of German chemical industry is due to two causes; first, the fact that their universities are practical institutions properly supported by the State, and in touch with the educated community; and, secondly, the factories are in the hands of experts. The development has been from within, though it has received great assistance from public sources. The academic party has worked under conditions of freedom, of *Lehrfreiheit* and *Lehrnfreiheit*, whereas in England the tradition that it is necessary to be well-read instead of well-practised has prevailed.

Dr. Beilby, in a paper on chemical engineering, distinguished between the engineer proper and the chemical engineer, rather to the detriment of the latter, though he does not overlook the fact that, if the engineer is not in full sympathy with chemical problems, and acquainted with the action of chemical substances on his materials, his plant will be a failure. The chemical works engineer is called a more adaptable but a rougher type of man, though it is afterwards admitted that he is "born, not made." It is the possession of large numbers of highly, specially trained chemists and engineers which gives the German chemical works its commanding position.

THE NATIONAL PHYSICAL LABORATORY IN 1914–15.

ANY review of the work of the National Physical Laboratory during the year 1914–15 should be prefaced by a tribute to the ready response with which the staff greeted the call to the colours at the outbreak of war. In the annual report of the laboratory, presented on June 15, at the Royal Society, to the General Board, attention is directed to the consequent marked reduction in the staff and its effect upon the distribution of duties. Many who were prepared to volunteer had to be retained by reason of stress of war work. Some 25 per cent. of the total staff were spared for service.

Dealing with matters of finance, a recovery in receipts since September and the maintenance of a stringent economy throughout contributed to a year's total which was not so unsatisfactory as had been apprehended during the earlier stages of the war. The report points out, however, that an enforced economy may well, if too long continued, prove disastrous. Special mention must be made of the generosity of the Hon. Sir C. A. Parsons, in placing a sum of 1000*l.* at the disposal of the committee; this enabled some serious gaps in equipment to be filled. Steps were taken in July, 1914, to proceed with a recommendation of Lord Parker's Committee on Research in Telegraphy and Telephony, on which the director of the laboratory, Dr. Glazebrook, was serving. It was proposed to establish at Teddington a National Telegraphic Research Laboratory. Since the outbreak of war, however, the matter has been in abeyance.

With regard to test work it may be said, in brief, that the war conduced to a shrinkage in aggregate, but, at the same time, to a large increase in some directions, notably in the electrotechnics and the optics divisions. International work of all kinds has practically come to a standstill. It should further be emphasised, before touching more specifically on the progress of the laboratory during the year, that the research work had, by force of the abnormal conditions prevailing, to be diverted in a large measure to abnormal channels.

A full list of papers published by, or communicated from, the laboratory during the last two years will be found in the report. The twelfth volume of "Collected Researches" is shortly to be issued.

To pass to a few details of the report, mention should in the first place be made of a series of inter-comparisons made during July last in collaboration with two visitors from the Physikalisch-Technische Reichsanstalt, Dr. Giebe and Dr. Scultze, between laboratory standards of resistance and inductance and some coils the absolute value of which had been determined previously at Charlottenburg. Further international measurements may also be noted. In Japan, differences of the order 8 parts in 1,000,000 were found between five mercury resistance standards, which had been constructed at the laboratory, and five tubes calibrated at Tokyo; whilst four Weston cells brought from Petrograd to Teddington agreed with the mean laboratory standard to within 1 part in 100,000. *Inter alia*, an important investigation of the irregularities commonly observed in the Weston normal cell was brought to a close during the year. An interesting series of experiments was also carried out in connection with the measurement of high-frequency currents. With suitably designed air- or iron-cored transformers it was found possible to measure, with precision, currents ranging from 1 to 50 amperes at frequencies from 50,000 to 2,000,000 ~ per sec.

Two valuable photometric papers claim attention. These deal with the unit of candle-power in white

light, as held in electric substandard lamps, and with the estimation of high temperatures by a method of colour identity. Reference may here also be made to the first report issued by the Committee on the Lighting of Factories and Workshops, of which the director of the laboratory is chairman. In the direct-current division good advance is reported with the research on the heating of buried cables.

With the co-operation of Dr. Schultze, two standard resistance thermometers, the constants of which had been studied at the Reichsanstalt, were re-examined at the laboratory. Owing to the war, no official comparison of the Reichsanstalt and the laboratory figures has been possible; but the two sets are known to be in close agreement. In a revision of the high-range mercury standard thermometers valuable assistance was given by Dr. René Paresce, of the Bureau des Poids et Mesures. The heat division was also occupied with research on refractory materials and on heat loss from surfaces.

In the metrology division the silica standard metre was kept under close observation, and it is promising to hear that no measurable extension could be detected during the year. Other items of interest are a series of rulings, undertaken for Prof. W. H. Bragg, to illustrate his work on X-ray spectra, and a report issued to the Board of Trade on leather-measuring machines and templates.

In spite of the absence of Dr. Kaye on active service, the radium division flourished during the year. Samples amounting to the value, 35,000*l.*, were submitted for test; up to March, 1914, the corresponding figure was 3000*l.* The division promises to thrive.

Not more than a broad selection can here be made from the numerous investigations of the engineering department. These range from experiments on the resistance of materials to alternating shear and combined stresses to an examination of cracks in the Tower of London. Considerable progress was made with a research on the methods of notched-bar impact testing, which is mainly concerned with a determination of the correct relation between the mass of the hammer, the velocity of striking, and the linear dimensions of the specimen, in order that tests on similar specimens on different scales may yield consistent results. Attention may also be directed to a report on power transmission through motor gear-boxes. On varying the quantity and the viscosity of the oil in such boxes, surprising alterations in efficiency were observed. Passing to the aeronautical division, the new 7-ft. wind channel is now in full working order. The researches of this division on the longitudinal and lateral stability of aeroplanes are well known, and call for no review here.

Interesting profiles of road surfaces at various stages in test were obtained by the Road Board laboratory, and numerous road materials examined under the microscope and otherwise.

Of the work accomplished during the year by the department of metallurgy, it must suffice to instance important researches on the constitution of aluminium-zinc-copper and copper-tin alloys, and an investigation of a new reagent for etching steel. Mention should also be made of some tests carried out by the chemical division on optical glasses, and of a report issued to the Board of Trade giving the results of an investigation into the precautions necessary in the transport of barium peroxide at sea. Some serious fires at sea, notably that on the *Volturno* in October, 1913, have been attributed to the spontaneous ignition of cargoes of this substance. Results of great interest will be looked for from the newly-erected rolling mill.

Compared with last year's abnormal figure, the number of models for private firms tested this year in the National Tank proves somewhat moderate. By suitable form modification, reductions of power at service speed, ranging to 13 per cent., were secured. Various researches were either continued or completed. In conjunction with that relating to fulness of form and longitudinal distribution, special study was made of the wave systems formed by the models. Furthermore, attention was directed to the question of the similarity law suitable for strut-resistance. Unless suitably corrected, the resistance of a full-scale strut may, on the basis of measurements on a model, prove enormously over-estimated.

That for a brief review numerous items of interest must pass unmentioned is inevitable. Sufficient, however, has been said to testify to the energy and success with which the work continues to be carried on despite adverse circumstances. It is to be hoped that, during the present emergency, every advantage will be taken of facilities which the laboratory can offer. Perfection and efficiency in all supplies of instruments and technical apparatus, with expedition in dealing with special questions, spell success to those fighting on sea and land.

HEATING AND VENTILATING SYSTEMS.

MR. D. D. KIMBALL, the president of the American Society of Heating and Ventilating Engineers, and a member of the New York State Commission on Ventilation, has sent us two papers, one on the heating and ventilation of school buildings, and the other on church ventilation. He says that most of the failures of the past may be justly attributed to insufficient appropriations for the installation of ventilating systems and for their maintenance and operation. Very many installations are incomplete, ill-designed, and installed with the use of unsuitable and cheap apparatus. Possibly the most frequent and serious cause of failure is the want of proper skill in operation. Plants are operated by boys or janitors who know absolutely nothing of the rudiments of fuel-burning, or care of a steam plant, or of a ventilating system. Often, too, there are such restrictions applied by the authorities that the proper operation of the plant is impossible. A school board, for example, directs that the plant must not be operated before or after certain dates, regardless of outside weather conditions, or offers a bonus to the janitor for saving coal, and yet directs that he must always operate his fan engines. He removes the belt between engine and fan, and so secures his bonus.

Mr. Kimball rightly insists on the heating and ventilation of schools being considered of the first importance in the estimates of any public building. Far too much is thought of the external appearance. The architecture should be adapted to the perfection of the physiological needs of the occupants, and the heating and ventilating engineers should be of equal authority with, not subservient to, the architect. A plan is given of the Wm. H. McKelvey School, of Pittsburgh. The air is taken through windows into a fresh-air chamber, from which it passes through tempering heaters, air-washers, and reheaters into a double plenum chamber. From there it is driven by a motor fan into ducts with connections from the upper, or hot air, chamber and the lower, or tempered air, chamber. An individual duct runs to the base of each vertical flue communicating with the class-rooms. The mixing and volume dampers for each room are placed in the plenum chamber, under control of the janitor.

The chief advantage of this system is that the required volume and temperature demanded by each individual room may be had. Two sides of a building

may be warmed by the sun while the other two sides are cooled by a cold wind. The occupants of rooms on these sides may require air ten degrees higher in temperature. The individual duct system allows them to get it. The direct radiators placed in the class-rooms cannot be depended upon to maintain the proper balance when a trunk system is used and air of the same temperature supplied to every room. The sunny side rooms need cooler air, and cannot get it by the trunk system. The individual duct system, moreover, is excellent in allowing monotony of atmospheric conditions to be avoided; a cooler or a warmer air may be had at will.

Mr. Kimball says: "The installation of the individual duct system increases the cost of the ventilating plant by two and one half per cent. in large, and five per cent. in small buildings." It is well worth it. He says automatic temperature-controlling systems may save ten to twenty per cent. of the annual fuel bill, and protect the class-rooms from excessive temperatures. By thermostatic devices in mild weather little or no steam is admitted to the class-room radiators, and cool air is delivered. In cold weather much steam is sent into the radiators and a warmer air delivered. Mr. Kimball says a thorough diffusion of the air through every portion of a class-room can be obtained by one or two fresh-air openings eight feet above the floor, with a single exhaust opening on the same side at the floor. The inlets should be directed towards the windows or be placed in the end walls as near as possible to the windows, and the outlet at the other end of the same wall near the floor. In churches and auditoriums the best results can be obtained by exhausting through mushroom openings near the floor and supplying air through openings in the walls or ceiling. The cool incoming air must be let in well above the occupants, so as not to cause unpleasant draughts.

In warm weather it is desirable to be able to reverse the current and send the cool air in at the floor. It is quite easy to arrange for this in the plant. Better still, both the in- and out-fans may be altered so as to impel into the building air which escapes through open doors and windows—an admirable plan. The cost of the plant such as sketched above is reckoned as about one and a halfpenny per cubic foot of space in the building. Only a proper combination of fresh-air supply and vitiated-air exhaust will afford a good ventilation in an auditorium. No occupant should be further than twenty-five feet from a fresh-air register or nearer than six feet to a vent register; the greater the number of both kinds of registers, the greater the satisfaction with the system. Direct radiators should be employed to balance loss of heat through windows and walls. They should be placed under windows, by doors, and along exterior walls. A large amount of radiation should be placed in vestibules to prevent annoying draughts.

In the temperate climate of Britain we can make do with an open fire and window system, which is intolerable in places where excessively low winter temperatures have to be faced. As, however, central heating is coming largely into use in public buildings, it is most necessary that it should be recognised that the true function of ventilation is to keep up the adequate loss of body heat and relieve the cutaneous sensations from monotony; that heating and ventilating systems must be kept separate and planned on the lines so well sketched out by Mr. Kimball; that architecture must be subservient to the demand for proper space, lighting, heating, and ventilation; and that intelligent, trained men (or women) are required to look after the systems of heating and ventilation, and work these so as adequately to cool, and avoid the monotony of, the occupants. L. H.

PROBLEMS OF MINE VALUATION.

THE State of Wisconsin has published a very interesting Bulletin under the title of "A Study of Methods of Mine Valuation and Assessment, with special reference to the Zinc Mines of South-western Wisconsin," by W. L. Uglow, which is well worthy of the attention of anyone concerned in the knotty problems of mine valuation. The Wisconsin Legislature has decided to impose a tax upon mineral property, which is to be valued on the same principle as is applied to all real estate in that State, namely, the "full value which could ordinarily be obtained therefor at private sale"; this phrase is not quite clear, but apparently means the value that could be realised under a sale from a willing seller to a willing purchaser. The difficulties that beset such a valuation in all circumstances are increased by the fact that in the majority of cases these mines are leased by the mining companies from the royalty owners, whilst the necessary capital is often borrowed from banks, so that three separate parties are interested in the mining property. It is interesting to note that the royalty payable to the owner varies from 5 to 15 per cent., averaging 10 per cent. on the gross receipts, the owner paying as a rule the real property tax upon the increased value of his land due to the fact that it is mineral-bearing, as well as an income tax upon the royalty that he receives.

Two points of general interest are to be found in the treatment of the royalty and of the interest upon the capital borrowed for working the mine, the author holding that neither of these can equitably be considered as an addition to working costs, but that both must be looked upon as coming wholly out of profits. Probably few will question this treatment of interest, but the royalty question appears much more open to discussion. Unfortunately most of the other points dealt with have only a local rather than a general interest, because the ore-bodies are all shallow, and the life of mines in this district is consequently only a short one, so that the methods of valuation here employed have only a limited application.

A number of methods of valuation are discussed in detail, namely: (1) The Finlay *ad valorem* method, which calculates the value of a mine as the present value of the average annual profits that may be expected to be obtained during the life of that mine, setting aside an annual sinking fund instalment, the total amount of all of which instalments, at the end of the estimated life of the mine, will amount to the present value. (2) The Arizona method, which takes the value of a mine for the purposes of taxation as represented by one-eighth of the gross production of the previous year, four times the net profit of the previous year and the value of the improvements. (3) The Colorado method, which takes the value as one-fourth of the value of the gross output of the preceding year, unless the net exceeds one-fourth of the gross, in which case the net output is taken to be the assessable value, except in the case of mines of the precious metals, where the value is taken to be half the value of the gross output plus the entire net output. (4) The Equated Income method, which takes the value as the present value of all future profits, these latter being taken as equal to the actual profits of the preceding year, excluding royalty, interest, and amortisation charges, assuming the same average length of life for all the mines of a district.

The author compares all these methods, and appears to decide in favour of the last-named. He is quite alive to the difficulties of the problem, and is also careful to point out the fact, too generally overlooked in the taxation of mines, that mining property is a wasting asset, and on this account ought not to be taxed on the same basis as ordinary real estate.

RECENT PROGRESS IN PYROMETRY.[1]

DURING the past five years, which is the period intended to be covered by the present paper, considerable advances have been made in the production of instruments for the measurement of high temperatures. Much valuable work in this direction has been carried out at the National Physical Laboratory in this country, and at the United States Bureau of Standards; and the manufacturers of pyrometers, chiefly in Britain and America, have introduced many new instruments for scientific and industrial purposes. Owing to the claims of atomic and molecular physics, the subject of pyrometry has not received that attention from physicists in general to which it is entitled by its industrial importance. The progress made in various directions may conveniently be considered under separate headings.

Standards of Temperature.

Various investigations of fixed points have confirmed, or at the most slightly modified, previously accepted figures. Up to the highest reading obtainable on the gas scale (1550° C.), the standards now in use appear to be well established; and beyond this the melting-point of platinum, as deduced by several different methods, is now accepted as 1755° C. This is a useful fixed point for the calibration of high-reading pyrometers.

The United States Bureau of Standards now issues materials of certified fixed points for the calibration of pyrometers. This procedure might with advantage be followed by our own National Physical Laboratory, so as to enable the indications of pyrometers to be checked from time to time by the user. If accompanied by instructions for use, a correct result would be ensured, and the danger of error resulting from the employment of materials of doubtful purity eliminated.

Thermo-electric Pyrometers.

One of the chief features of recent years has been the extension of the use of base-metal junctions in place of platinum and platinum alloys. Suitable base-metal couples develop a relatively high E.M.F., and enable a strong and cheap indicator to be used in place of the sensitive instrument required for couples of the platinum series. Most makers now furnish iron-constantan pyrometers, which may be used up to 900° C. R. W. Paul employs two iron-nickel alloys of different composition which will register 1000° C.; whilst the Foster Instrument Company use two nickel-chromium alloys, capable of reading to 1200° C. in continuous use, and to 1300° C. for occasional observations. For temperatures below 700° C. copper-constantan junctions are much used, as, for example, in pyrometers for superheated steam. Various other base-metal couples are in use.

The trustworthiness of base-metal junctions has been called into question by Kowalke (Transactions of the American Electrochemical Society, vols. xxiv. (1913) and xxvi. (1914)). Trials made on junctions of this type, as supplied by American makers, showed changes in calibration on heating for twenty-four hours ranging from 20° C. to 130° C., the higher figure being obtained at temperatures of 1000° C. The results showed the necessity of "ageing" the junctions by prolonged heating at the maximum temperature prior to calibration. Experience with British-made junctions shows that large errors of this nature do not occur, owing to a careful choice of materials and suitable treatment before calibrating.

C. C. Bidwell (*Physical Review*, June, 1914) has shown that a junction of carbon and graphite may be used to read temperatures as high as 2000° C. Previous heating to this temperature is necessary before calibrating in order to expel volatile matter. This junction gives promise of a valuable extension of the range of thermo-electric pyrometers, and may find industrial applications.

Materials for protecting junctions from the corrosive action of furnace gases have been added to by the introduction of alundum (oxide of aluminium), which melts at 2050° C.; a material known as "silit," which has a carborundum basis; and "silfrax," a substance resembling carborundum. All these materials are brittle, and therefore will not stand rough usage. As a protection for junctions used to read the temperature of molten brass or bronze, a tube of molybdenum has proved successful, as this metal is a good conductor of heat and is not acted on by the molten alloy.

Indicators for thermo-electric pyrometers have been improved in details by the various makers, resulting in greater trustworthiness. A new departure in commercial indicators has been made by the Leeds and Northrup Company of Philadelphia, who have adopted the potentiometer principle, formerly used only for accurate laboratory work. The connections are shown in Fig. 1, where B is a 2-volt accumulator, R_1 an

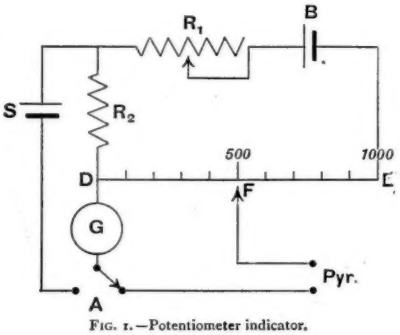

FIG. 1.—Potentiometer indicator.

adjustable resistance, R_2 a fixed resistance, DE a uniform stretched wire, S a standard cell, G a sensitive galvanometer, and A a switch. In order to maintain a steady fall of potential along DE, R_1 is adjusted so that on switching the standard cell into the circuit of the galvanometer, no deflection is observed. As the voltage of B falls off with use, this adjustment must be made from time to time. The pyrometer is connected to one terminal of the galvanometer and to a sliding contact F, which, in taking a reading, is moved along DE until no deflection is observed on G. From the known relation between temperature and E.M.F. for the junction used, DE may be graduated so as to read temperatures directly. The advantages of this arrangement are greater sensitiveness and independence of the resistance of the pyrometer and leads; the drawback, from an industrial standpoint, is that the readings are not automatic. Several methods for adapting an indicator for special ranges have been devised. In one form, due to the Cambridge Scientific Instrument Company, the indicator takes the place of the galvanometer G in Fig. 1, and by fixing the slider F at a given position—representing, say, 500°—the pointer of the indicator is prevented from moving until this temperature has been reached by the junction. The zero of the indicator is thus made to represent 500°, and

[1] Abstract of a paper read before the Royal Society of Arts on May 12 by Mr. Chas. R. Darling.

by keeping F fixed, the whole of the scale may be utilised for reading from 500° upwards. A more open scale, with correspondingly closer readings, may thus be obtained; and by suitable adjustment of F the range covered may be varied as required. The same firm has also introduced a mechanical device for achieving the same object. In this a suspended-coil indicator is used, and by turning a torsion head a twist is imparted to the suspension, so that the pointer does not move over the scale until the temperature of the junction has reached an assigned figure. In the multi-range instrument made by R. W. Paul, the indicator takes the place of the galvanometer in a Wheatstone bridge circuit, the pyrometer being in series with the indicator. By throwing the bridge slightly out of balance, a current may be made to pass through the indicator in an opposite direction to that produced by the heated junction; and only when this opposing current is overcome will the pointer begin to move over the scale. Resistances are provided which, when inserted in the arms of the bridge, disturb the balance so as to hold up the indicator until an assigned temperature—say 600°—is

FIG. 2.—Pyrometer for superheated steam.

reached, when the whole scale becomes available for the selected range. By using two manganin and two copper resistances in the arms of the bridge, automatic correction is made for changes in the temperature of the cold junction. Thus, if the bridge were balanced at 20°, a current would flow through the indicator at any other temperature, as copper changes its resistance on heating or cooling, whilst manganin does not. The resistances are so chosen that the movement of the pointer caused by this current represents the increase or decrease in the temperature of the cold junction, and thus any errors due to this cause are eliminated.

The regulation of the temperature of superheated steam on locomotives has given rise to the problem of producing an indicator practically unaffected by vibrations. This has been solved in various ways by different makers, and satisfactory instruments are now procurable for this purpose. Fig. 2 shows a pyrometer of this type made by Messrs. Siemens. Altogether, great progress has been made in this branch of pyrometry, particularly in the direction of greater accuracy.

Resistance Pyrometers.

No special change is to be recorded in connection with this class of instrument. The recent work of Sir William Crookes has shown that platinum is distinctly volatile above 1000° C., and this explains satisfactorily why resistance pyrometers were found to change their calibration when used above this temperature. For work at low or moderate temperatures the resistance pyrometer is much used on account of its superior accuracy, which, however, is only operative when the temperature to be measured is subject to precise control. It is now customary to employ thermo-electric pyrometers for the general run of metallurgical work, and to use a resistance pyrometer for very exact work, and for a workshop standard within its upper limit—1000° C.

The researches of Northrup on the resistance of molten metals (*Journal of the Franklin Institute,*

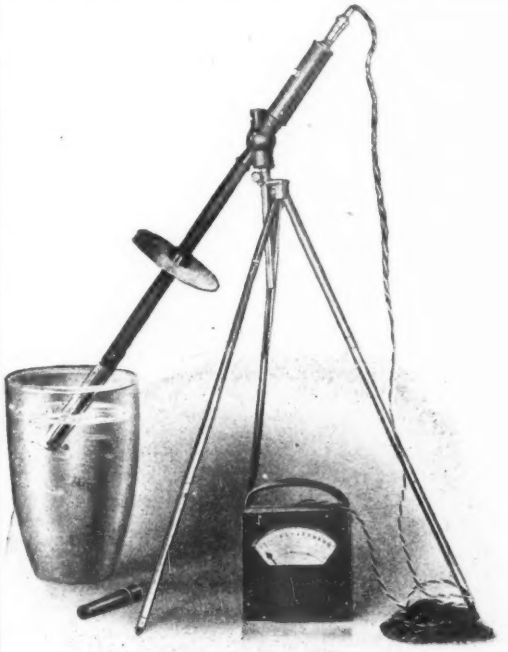

FIG. 3.—Foster's radiation pyrometer for molten metals.

January and March, 1914) suggest a possible extension of the range of resistance pyrometers by the use of a liquid element. Melted copper, for example, shows a uniform increase in resistance up to 1400° C., and this fact might be utilised in measuring temperatures if a suitable appliance were forthcoming. The decrease in the resistance of pyro-conductors with rise in temperature may possibly be utilised for resistance pyrometers. Alundum, for example, has a resistance of 6100 ohms per cm. cube at 1100° C., which falls to 190 ohms at 1600° C.—an average decrease of nearly 12 ohms per degree, which could easily be detected on a coarse instrument.

Radiation Pyrometers.

A distinct improvement in these instruments has been the introduction of pivoted indicators in place of the suspended-coil type formerly in use. This has

been made possible by the use of more sensitive junctions to receive the radiations. The Féry pyrometer has been modified by Whipple for determining the temperature of molten metals by mounting the pyrometer at the open end of a fireclay tube, so as to be permanently focussed on the closed end which is immersed in the metal. Foster uses a similar plan in connection with his fixed-focus pyrometer (Fig. 3) the end being closed by a salamander tube which is dipped into the metal. The telescope is pierced by a tube open at both ends, through which air may be

FIG. 4.—Paul's radiation pyrometer.

forced with the view of preventing fumes from reaching and corroding the mirror in the event of breakage of the immersion tube. Mr. R. W. Paul has introduced a radiation pyrometer in which the rays are received in a tube containing a polished cone, a junction at the apex receiving the radiations. This type of instrument, originally due to Thwing, gives the same reading at all distances within a given limit, and therefore requires no focussing. A unipivot galvanometer is used as indicator (Fig. 4). A high

FIG. 5.—Heathcote's extinction pyrometer.

degree of accuracy has now been attained with radiation pyrometers, as is proved by tests on commercial instruments conducted at the National Physical Laboratory.

Optical Pyrometers.

The standard forms due to Féry, Wanner, and Holborn and Kurlbaum are now well established, and have been improved in details with a view to industrial use. A new type of optical pyrometer, based on the principle of colour extinction, has been introduced. In the form devised by Heathcote in the Research Laboratory of the Rudge-Whitworth Company, cells containing a liquid of the correct colour and density are used, so that the luminous rays from the heated object are extinguished at a given temperature. The instrument consists of an eye-shade (Fig. 5) in which four cells are mounted, two of which are capable of extinguishing the light at the working temperature, whilst the other two correspond to a slightly higher temperature. Either pair may be brought before the eyes by moving a slide, and when the heated object is just visible in the lower pair, but invisible in the higher, the correct temperature has been attained. In another form a single cell is used, in which the depth of liquid may be adjusted until extinction occurs, and the temperature read off on a scale graduated in temperatures according to the depth.

FIG. 6.—Alder and Cochrane's extinction pyrometer.

Another form of extinction pyrometer has been designed by Alder and Cochrane (Patent No. 27,633, 1913), shown in Fig. 6. This consists of a small telescope, the rays through which are intercepted by a wedge of dark-coloured glass, which is moved until the sighted object just ceases to be visible. Temperatures are read from a scale which moves with the prism, and the range may be increased by inserting a piece of tinted glass in the eyepiece, and reading from a second scale prepared with the glass in position.

An important paper, embodying results which suggest a new type of optical pyrometer, was read by Paterson and Dudding before the Physical Society in March, 1915. It was shown that the temperature of many metallic substances could be measured by matching the colour against that of a black body until identical. A Lummer-Brodhun photometer was used, and the temperature of the black body varied until equality of hue was obtained. Filament lamps, with an ammeter and rheostat in the circuit, were thus matched, and became secondary standards, a given current corresponding to a known temperature. An optical pyrometer on these lines appears quite feasible.

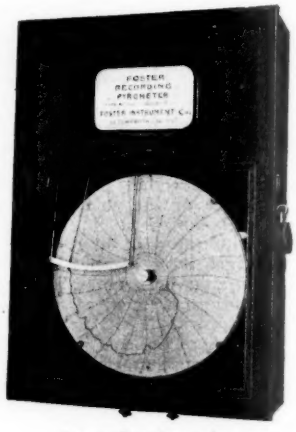

FIG. 7.—Foster's recorder.

Lovibond has suggested an optical pyrometer in which a standard source of light is brought to equality of tint with the heated object by interposing tintometer glasses.

Recorders.

The value of temperature records is now so much recognised in the industries that all makers of pyro-

meters have given special attention to recorders, and have devised arrangements for registering the readings of several pyrometers simultaneously. For resistance pyrometers the well-known recorder of Callendar is much used, and the modern form of Roberts-Austen photographic recorder, made by the White Instrument Company, is of great service in accurate work with thermo-electric instruments. Of the more recent types Foster's recorder (Fig. 7) possesses an indicator pivoted horizontally, the pointer being vertical and moving across a circular chart rotating about its centre once in twenty-four hours. At short intervals a presser-bar is urged against the pointer, at the end of which is placed a capillary tube containing an inked wick. A mark is thus made on the chart corresponding to the position of the pointer; and as the lines radiating from the centre are divided into temperatures, a complete record, visible in its entirety, is made.

The thread recorder of the Cambridge Scientific Instrument Company has been improved in many details. One of the latest forms is shown in Fig. 8, in which two indicators are made to record on a single chart wound on a long drum rotated by clockwork. The presser-bar in this case pushes the pointer on to an inked thread, which touches and leaves an ink-dot on the graduated chart. By having two threads, coloured with different inks, and a mechanism which brings each thread in turn beneath the pointer, four simultaneous records may be taken, the pyrometers concerned being automatically switched on to the indicators in correct sequence.

A recorder in which the mechanism is driven by a motor has been introduced by the Leeds and Northrup Company, and is much used in the United States. R. W. Paul has also adopted the motor-drive in his new recorder (Fig. 9), which also embodies other novel features. The chart is made in the form of a continuous roll, lasting for 1000 hours, a large part of which is open to inspection through a window extension. The pointer is pressed periodically on to an inked ribbon, which touches the chart at a place where the latter is passing over a knife-edge, and hence a dot is produced. Change-gear for altering the speed may be inserted when desired, and duplicate records are secured by means of a second ribbon, of different colour, which may be made to alternate in position with the first ribbon beneath the pointer. When a resistance pyrometer is in use, a Harris indicator replaces the galvanometer, a new chart, divided to suit this indicator, being inserted.

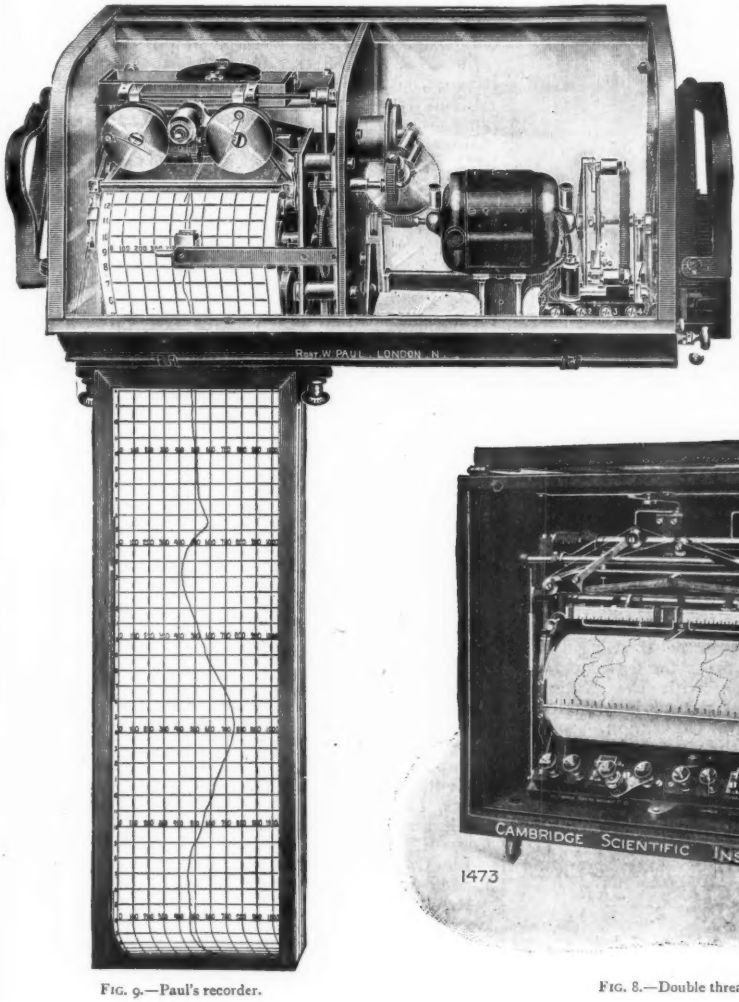

FIG. 9.—Paul's recorder.

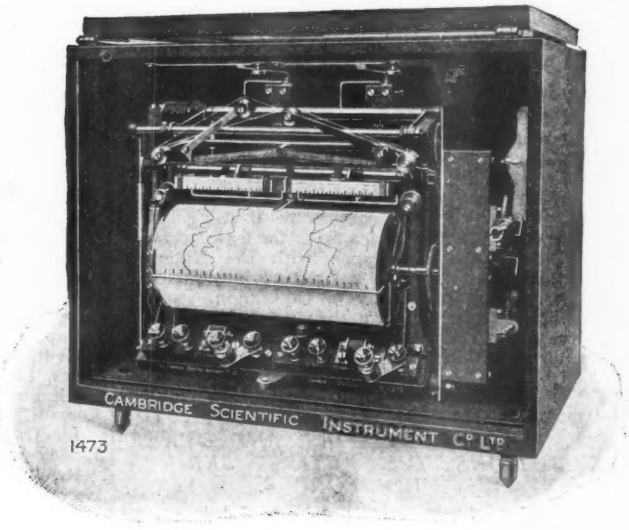

FIG. 8.—Double thread recorder.

In the latest form of Siemens' recorder, a long chart, visible over a considerable length through a window (Fig. 10) is also used. It is furnished with a

FIG. 10.—Siemens' recorder.

pivoted galvanometer, and the pointer is pressed on to an inked ribbon which touches the chart. Clockwork is used to actuate this recorder.

Conclusion.

The substantial advances made in this country in pyrometry during recent years may be cited as a useful guide as to how industry may be created and preserved. All the places at which pyrometers are made in Britain are under the direction of skilled scientific men, who are constantly devising new instruments and finding wider fields for their application. All are in close touch with the National Physical Laboratory, which has proved invaluable to them in securing uniformity of calibration, and in other ways. The result is a thriving and extending industry, not threatened by foreign competition, and not requiring artificial props to ensure its success.

MEMBERS OF SCIENTIFIC STAFFS OF UNIVERSITIES, COLLEGES, AND OTHER INSTITUTIONS ON ACTIVE SERVICE WITH H.M. FORCES.

SINCE the publication, in our issue of July 15, of the list of members of scientific staffs of universities, colleges, and other institutions on active service with H.M. Forces, we have received further lists which for various reasons did not reach us earlier. The names in the list subjoined are supplementary to those published in our register last week. In each case the list is limited to men who have been gazetted or have enlisted in one of the Services.

At the Meteorological Office permission to offer their services to the War Office or other Government department associated therewith for the period of the war has been given to Mr. G. I. Taylor, Schuster reader at Cambridge, and twelve members of the clerical and technical staff. Three of the attendants have left the service of the office to enlist. On the other hand, the professional and scientific staff has been increased for special duty in connection with meteorological field service by the addition of six meteorologists, three of whom are volunteers. More volunteers with professional qualifications in physics and mathematics are required for duty at the observatories.

BIRMINGHAM: UNIVERSITY.

Anderson, Dr. J. S., assistant lecturer in physics, Officers Training Corps.
Chadwick, P.M., assistant lecturer in civil engineering, 2nd Lieut. 2/2 Field Co., East Ang. Div. R.E.
Coates, J. E., special lecturer in physical chemistry, Lieut. R.N.V.R., attached to Air Department.
Johnson, G. E., assistant in agricultural zoology, 2nd Lieut. 15th (S.) Batt. Royal Warwick Regiment.
Jones, R. A., headmaster of training college for men, Major 15th (S.) Batt. Royal Warwick Regiment.
Lea, Dr. F. C., professor of civil engineering, 2nd Lieut. Officers Training Corps.
McCombie, Dr. Hamilton, assistant lecturer in chemistry, Lieut. 3/7 Worcester Regiment.
Panton, R. C., assistant lecturer in civil engineering, 2nd Lieut. 2nd Royal Dublin Fusiliers (wounded).
Thomas, W. Norman, lecturer in civil engineering, 2nd Lieut. 213th Fortress Co. R.E. (Warwicks).
Whitworth, E. S., assistant in training college for men, Lieut. 10th (S.) Batt. Royal Warwick Regt.
Wishart, W. G., assistant lecturer in machine design, Mechanical engineering, 2nd Lieut. Roy. Gar. Artil.

LEEDS: UNIVERSITY.

Atkin, W. R., assistant lecturer and demonstrator in leather industries, 2nd Lieut. 5th Batt. K.O.Y.L.I.
Birch, de B., professor of physiology, assistant director of medical services, 2/1st W.R. Division T.F.
Carr, W., assistant in textile department, driver Army Service Corps.
Comber, N. M., assistant lecturer in agricultural chemistry, Lieut. 8th Batt. Yorks.
Dyson, H. A., assistant in textile department, private 15th Batt. West Yorks.
Firth, A., mechanic in engineering department, Sergt. 7th Batt. West Yorks.
French, W. E., assistant lecturer and demonstrator in electrical engineering, Lieut. 17th Batt. W. Yorks.
Goode, C. W., milk tester in agriculture department, private T.F.
Hampshire, P., assistant in leather industries department, private R.A.M.C.
Jones, Ll. R., assistant lecturer in geography, Capt. 7th Batt. West Yorks.
Lee, E., assistant lecturer in agricultural botany, Lieut. 4th Batt. W. Riding (killed in action July 10).
Lloyd, W. G., demonstrator in physiology, Lieut. R.A.M.C.
Newby, A., assistant in textile department, private R.A.M.C.
Nuttall, J. M., demonstrator in physics, 2nd Lieut. 11th Batt. York and Lancasters.
Perkins, W. H., assistant lecturer and demonstrator in chemistry, Capt. O.C. Leeds Univ. O.T.C.
Potter, V. J., laboratory assistant in agriculture, private 15th Batt. West Yorks.
Priestley, J. H., professor of botany, Capt General Staff, Expeditionary Force.
Watts, A. E., mechanic in physics department, private 15th Batt. West Yorks.
Westmoreland, A., laboratory attendant in geology, bugler 7th Batt. West Yorks.
Whitaker, G., laboratory attendant, private R.A.M.C.
Woodhead, A. E., demonstrator in tinctorial chemistry and dyeing, Lieut. Leeds University O.T.C.

LONDON: THE LISTER INSTITUTE.

Martin, Dr. C. J., director, Major A.A.M.S.
Petrie, Dr. G. F., assistant bacteriologist, Lieut. R.A.M.C.
Rowland, S., assistant bacteriologist, Major R.A.M.C.
Robison, Dr. R., assistant in biochemistry, Lieut. R.A.M.C.

OXFORD: UNIVERSITY.

Bourdillon, R. B., chemistry tutor, University College, Lieut. R.F.C. (S.R.).
Edmunds, P. J., demonstrator in physics, 2nd Lieut. Royal Engineers.
Hartley, H. B., chemistry tutor, Balliol College, Capt. 7th (S.) Batt. Leicestershire Regiment.
Schuster, E. H. J., biology fellow, New College, Lieut. Wessex Royal Garrison Artillery.
(Gill, W. B., demonstrator in physics, is Lieut. in the R.E. and not R.G.A., as stated last week.)

SIDMOUTH: THE HILL OBSERVATORY.

Lockyer, Dr. W. J. S., chief assistant, Lieut. R.N.V.R. (Air Service).

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The following awards for research have been made at Emmanuel College:—Studentship of 120*l.*, J. Conway Davies, for research on the baronial opposition to Edward II.; studentship of 100*l.*, O. H. Hoexter, for an investigation of certain problems of currency; grants from the Research Studentship Fund, G. Matthai, Mackinnon student of the Royal Society, 50*l.* towards expenses while investigating the morphology of coral; J. Morrison, 60*l.* towards the expenses of investigation of the relative age of the intrusive rocks in the Shap district.

LONDON.—Dr. F. A. Bainbridge has been appointed to the University chair of physiology, tenable at St. Bartholomew's Hospital Medical School. He has been professor of physiology at Durham since 1911.

The D.Sc. degree in organic chemistry has been granted to Mr. O. L. Brady, Royal College of Science, and the D.Sc. degree in engineering to Mr. Oscar Faber, an external student.

A new Board of Studies in Horticulture has been constituted, and regulations have been approved for diplomas in town-planning and civic architecture, and in town-planning and civic engineering.

Honorary bachelor degrees are to be conferred, in faculties other than medicine, on internal students who, on account of war service, have been prevented from completing the courses of study and examinations for their degrees.

MANCHESTER.—Since the outbreak of the war 520 cadets have been granted commissions. Of these 210 were not members of the University, but were enrolled in the University Officers Training Corps, under the command of Major Sir Thomas Holland, the professor of geology. The officers of the contingent have specialised in such subjects as map reading, elementary field engineering, infantry tactics, military law, signalling, and army organisation. Cadet Sergt. Edgar has also given lectures on military history. Students in the department of economics have been working under the direction of Prof. Chapman, in collecting statistics for the Board of Trade. In the chemical, metallurgical, and engineering departments, both in the faculty of science and that of technology, important work is being done for the War Office and for the Admiralty, and a considerable number of the members of the staff and students are engaged in scientific investigations and tests for the Government. The women members of the staff have organised among the women students two Red Cross detachments and other groups offering special social service.

Science announces that Mr. J. J. Hill has given 25,000*l.* to Harvard University to endow a professorship of transportation in the graduate school of business administration. We learn from the same source that a trust fund of 20,000*l.*, the proceeds of which are to be divided between the William Pepper Clinical Laboratory of Medicine and the Latin and Greek department, is bequeathed to the University of Pennsylvania under the will of Samuel Dickson, of Philadelphia.

THE trustees of the Beit Fellowships for Scientific Research, which were founded and endowed two years ago by Mr. Otto Beit, in order to promote the advancement of science by means of research, have recently elected to fellowships the following:—Mr. W. B. Haines, of Leytonstone, Mr. C. K. Ingold, of Chiswick; and Mr. H. N. Walsh, of Cork. Mr. Haines studied at University College, London, from 1907 to 1913, at the University of Göttingen, 1913–14, and has since been at the Imperial College. Mr. Ingold was an exhibitioner of the University of London in 1912, and a royal scholar in 1913; from 1911 to 1913 he was at the Hartley University College, Southampton. Mr. Walsh received his education in Ireland. He was a scholar, medallist, and prizeman at University College, Cork, and is now assistant to Prof. Alexander. The three fellows will carry on their respective researches in the Imperial College of Science and Technology.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, July 12.—M. Ed. Perrier in the chair.—J. **Boussinesq**: Reflections on the principles of the dynamics of Aristotle and their agreement with experiment in the case of uniform phenomena.—B. **Boulyguine**: The representation of an integral number by a sum of squares.—J. **Deprat**: The mode of formation of two Japanese volcanic centres, Aso-San and Asama-Yama, compared with the volcanic centres of ancient geological periods. The structure of the volcano of Aso-San is exactly comparable with the great volcanic centre of Anglona, in Sardinia. Asama-Yama has another type of structure, and in its mode of working recalls Mt. Pelée. It compares exactly with the trachyte dome of Monte Ferru, in Sardinia.—D. **Eginitis**: The geological phenomena observed during the two last earthquakes at Leucade and Ithaca. The dislocations due to seismic phenomena can be traced historically from the first century right up to the present time, and represent a continuation of the great geological phenomena which have separated the island of Leucade from the mainland of Greece. There is no conclusive evidence of volcanic manifestations, the appearance of clouds on the Leucade mountains, observed during the last earthquake, being most probably due to dust arising from the fall of rocks.—F. **Bordas** and S. **Bruère**: Contribution to the study of the phenomena of putrefaction. It is the custom in France, in the country, to bury small animals which have died on the farm in the manure heap. It is shown that complete resolution of the organic elements of the body takes place very rapidly under these conditions, the organisms present in the manure assisting the rapidity of the decomposition.—Marc **Tiffeneau**: Comparison of the various adrenalines and their homologues, measured by their action upon the arterial pressure in a dog under the influence of atropine. The dogs used in these experiments were

placed under the influence of chloral and atropine, and the advantages of this method are described. Lævorotatory adrenaline, either natural or synthetic, was proved to be from 15 to 20 times more active than its dextrorotatory isomer. This is in accordance with the fact already known, that the synthetic racemic compound has about half the activity of the natural adrenaline.—P. **Petit**: Some observations on malt amylase. Extracts with water or dilute alcohol contain a large proportion of foreign material and do not keep. By the use of aqueous acetone in the manner described a solution of diastase can be prepared the activity of which remains constant for several weeks. This solution can be precipitated by a mixture of ether and acetone, giving a disastase which can be dried, and which is of high activity.—Em. **Bourquelot**, M. **Bridel**, and A. **Aubry**: Researches on the preparation of glucosides from glycerol with the aid of α-glucosidase.

CAPE TOWN.

Royal Society of South Africa, June 16.—Dr. L. Péringuey, president, in the chair.—R. W. **Shufeldt**: Osteology of Palæornis with other notes on the genus. A description is given of one of the most abundant parrots of India—*Palaeornis torquatus*, or the ring-parrot—so named for the reason that in the adult a ring or collar forms a part of the plumage of the neck.—Miss A. V. **Duthie**: Note on apparent apogamy in *Pterygodium newdigatae*. This paper deals with a cleistogamous variety of the South African orchid, *Pterygodium newdigatae*, and is of special interest because cleistogamy, rare enough among orchids, appears here to be accompanied by apogamy. Sections of the ovary and column at various stages of development show no trace of pollen tubes. The gland-like "pollen masses," which remain permanently embedded in the tissue of the rostellum arms, do not appear to develop beyond the mother cell stage.—F. **Eyles**: A record of plants collected in Southern Rhodesia. This record includes representatives of 160 families, 869 genera, and 2397 species, besides 112 varieties. The flowering plants are arranged on Engler's system as set out in the "Genera Siphonogamarum" of Dr. C. G. de Dalla Torre and Dr. H. Harms, 1900–1907. The ferns and fern allies are arranged in accordance with the system of Engler and Prantl, as shown in the check list of flowering plants and ferns of the Transvaal and Swaziland by J. Burtt-Davy and Mrs. Pott, 1911. With regard to the lower cryptogams, the arrangement is that of Strasburger's "Text-book of Botany," 1903.—J. S. v. d. **Lingen**: Description of (1) a simple apparatus for finding "g"; (2) a simple apparatus for standardising a given vibrator.

BOOKS RECEIVED.

Prehistoric Society of East Anglia. Report on the Excavations at Grime's Graves, Weeting, Norfolk. March–May, 1914. Pp. 254+plates. (London: H. K. Lewis.) 5*s*. net.

Jahrbuch des Norwegischen Meteorologischen Instituts für 1914. Pp. xii+147. (Kristiania: Gröndahl and Sön.)

Nedboriagttagelser i Norge utgit av det Norske Meteorologiske Institut. Aargang xx., 1914. (Kristiania: Aschehoug and Co.) 3.00 kronen.

Canada. Department of Mines. Mines Branch. Petroleum and Natural Gas Resources of Canada. Vol. i. By F. G. Clapp and others. Pp. xviii+378. (Ottawa: Government Printing Bureau.)

Lessons in Elementary Physiology. By T. H. Huxley. Enlarged and revised edition. Pp. xxiv+604. (London: Macmillan and Co., Ltd.) 4*s*. 6*d*.

Steam Power. By Prof. W. E. Dalby. Pp. xvi+760. (London: E. Arnold.) 21*s*. net.

The Book of France. Edited by Winifred Stephens. Pp. xvi+272. (London: Macmillan and Co., Ltd.; Paris: E. Champion.) 5*s*. net.

Agricultural Laboratory Manual. Soils. By Prof. E. S. Sell. Pp. iv+40. (Boston and London: Ginn and Co.) 1*s*. 6*d*.

Aids to the Analysis and Assay of Ores, Metals, Fuels, etc. By J. J. Morgan. Second edition. Pp. viii+138. (London: Baillière, Tindall and Cox.) 3*s*. net.

The Science of Mechanics. A Critical and Historical Account of its Development. By Prof. E. Mach. Translated by P. E. B. Jourdain. Pp. xiv+106. (Chicago and London: The Open Court Publishing Co.) 2*s*. 6*d*. net.

Contributions to the Founding of the Theory of Transfinite Numbers. By G. Cantor. Translated by P. E. B. Jourdain. Pp. ix+211. (Chicago and London: The Open Court Publishing Co.) 3*s*. 6*d*. net.

Selections from the Scottish Philosophy of Common Sense. Edited by G. A. Johnston. Pp. vii+267. (Chicago and London: The Open Court Publishing Co.) 3*s*. 6*d*. net.

The House Fly: a Slayer of Men. By F. W. Fitzsimons. Pp. vi+89. (London: Longmans, Green and Co., Ltd.) 1*s*. net.

The British Mycological Society. Transactions for the Season 1914. Vol. v., part i. May. Pp. xii+186. (Worcester: E. Baylis and Son.) 10*s*. 6*d*.

CONTENTS.

	PAGE
Forestry and Trees	555
Dynamometers. By **J. P.**	557
Mathematical Text-Books	558
Electricity and Magnetism. By **J. R.**	559
Our Bookshelf	559
Letters to the Editor:—	
The Structure of Magnetite and the Spinels.—**Prof. W. H. Bragg, F.R.S.**	561
The Magnetic Storm of June 17, and Aurora.—**Dr. C. Chree, F.R.S.**	561
Surface Tension and Ferment Action.—**Dr. W. Cramer**	561
Origin of a Mathematical Symbol for Variation.—**Prof. Florian Cajori**	562
Science and Munitions of War	562
The Evolution of the Goniometer. (*Illustrated.*)	564
Chemical Fire-Extinguishers	565
The Surgery of the War	566
Notes	567
Our Astronomical Column:—	
A Bright Meteor, July 17	571
The Determination of Easter Day	571
Cepheid-Geminid Variability	572
Variable Stars	572
The Society of Chemical Industry	572
The National Physical Laboratory in 1914–15	573
Heating and Ventilating Systems. By **L. H.**	574
Problems of Mine Valuation	575
Recent Progress in Pyrometry. (*Illustrated.*) By **Chas. R. Darling**	576
Members of Scientific Staffs of Universities, Colleges, and Other Institutions on Active Service with H.M. Forces	580
University and Educational Intelligence	581
Societies and Academies	581
Books Received	582

Editorial and Publishing Offices:
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.

Advertisements and business letters to be addressed to the Publishers.

Editorial Communications to the Editor.
Telegraphic Address: PHUSIS, LONDON.
Telephone Number: GERRARD 8830.

5

ens.
td.;

Prof.
Sinn

tals,
Pp.
3s.

rical
ach.
106.
ning

of
l by
Lon-
et.
mon
267.
ning

Fitz-
reen

for
186.

PAGE
555
557
558
559
559

561

561

561

562
562
564
565
566
567

571
571
572
572
572
573
574
575

576

580
581
581
582

the